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INDUSTRIAL NOTES..... 167

A water supply insufficient for fire protection is pretty sure to bring about an increase in insurance rates, or a cancellation of policies, as the people of Long Island City, N. Y., and Bath, Me., seem just now to be finding out. At Bath it is reported that since a recent fire, during which the water supply is alleged to have been deficient, the insurance rates have been put up 50%, while at Long Island City the insurance men threaten to cancel all policies unless the water and fire protection service are immeditaetly improved. The results of this latter course may be appreciated to some extent when it is said that the banks holding mortgages on property in Long Island City threaten, in case the insurance companies cancel the policies, to at once foreclose all mortages held on property in the city.

A state inspector of the water meters is proposed in Massachusetts, a bill for the appointment of such an official by the governor having been introduced in the legislature recently. The bill provides a salary of $3,500 per annum and traveling expenses, but seems to make no allowance for office and other expenses. An office must be maintained in Boston and a report made in January of each year to the legislature. All water departments and companies would be obliged by the law to provide proper tanks and scales and furnish all necessary labor and other facilities for testing and inspecting without cost to the state. The salary and traveling expenses of the inspector would be collected by the state from the owners of the meters, but whether this means that a proper proportion of the expenses are to be assessed upon each meter in the state, or only upon those examined, and whether the meters in each municipality are to be tested is not stated in the information at hand. No meter may be kept in service when after six months' use a test shows a registration against the consumer. The number of meters in use in Massachusetts in 1890, according to the "Manual of American Water-Works" for 1891, was about 32,000.

The steel work of the great tower for London atWembley Park, in London, is now erected to a height of 150 ft., and it may be completed in the spring. London is also to have a gigantic wheel, 300 ft. high, on the plan of the Ferris wheel at Chicago, and it will have attached to its circumference 40 passenger cars, each to seat 40 person.

The cableway for carrying passengers across the Tennessee River at Knoxville, Tenn., on which a serious accident occurred this week, is 1,000 ft. long, and has a rise of 350 ft. The car is suspended from a carrier running on two 1⅛-in. wire cables, and is hoisted by a ½-in. wire rope driven by a power plant at the lower end, with two 20-HP. engines. Automatic brakes are supposed to hold the car in case of breakage of the hoisting rope. The car is 14 ft. long, with end platforms 3 ft. long, and its weight is 1,200 lbs. empty. It can seat 16 passengers. The hauling cable broke on Feb. 18, and one passenger was killed by the recoil of the broken end crashing into the car. The passengers were let down to a steamer anchored underneath the cableway.

A Harvard astronomical station is to be established in the clear, dry atmosphere of Arizona, by means of a fund donated for this purpose by Mr. Percival Lowell, of Boston. Mr. W. H. Pickering, a brother of Prof. Edward C. Pickering, of Cambridge Observatory, and the successful founder of the Peruvian-Harvard observatories, is to test and select the best and most suitable point in Arizona.

Plans and specifications for a "whaleback" warship were some time ago forwarded to the Navy Department by Capt. Alex. McDougall, of Chicago. As a result a commission has been appointed by Secretary Herbert to examine into and report upon the advisability of constructing a warship on this principle.

The Boston Subway Commission reports that the $2,000,000 provided for in the original bill authorizing subway construction is insufficient. They want a subway 10,000 ft. long and this would cost $5,000,000. They will present amendments to the bill to the legislature covering the work now contemplated.

The Platte River Canal project is before the public again through a report of a special committee of the Commercial Club of Omaha. The engineers engaged by the committee propose to supply at Omaha 21,000 HP. for 24 hours per day, or 40,000 HP. on a 10-hour basis, at an estimated cost of $3,000,000. The Omaha "Bee" does not look very kindly upon the project, as the estimates are very vague as to the additional cost of electrical plant. The contract is not fixed, and the committee is silent upon the important point of the method of raising the capital required. More detailed estimates of cost and operations are called for.

At the annual meeting of the Massachusetts Highway Association, Mr. Wm. E. McClintock, a member of the State Highway Commission, was elected president. In the course of his remarks Mr. McClintock stated that the estimated cost of 15-ft. stone roads was $5,000 per mile, assuming that suitable stone could be delivered by rail at $1.30 to $1.40 per ton, and that the average haul from the railway did not exceed one mile. The commission proposes to reduce all grades to about 5% maximum gradients as nearly as possible.

The New York & Hudson River Bridge bill is before the House Committee on Commerce, and those opposed to the bill had their first hearing on Feb. 14. The Secretary of War having been appealed to for his opinion referred the matter to Chief of Engineers General Casey, and this officer reports as follows: He suggests some changes in the bill, the most important of which are, that the bridge shall be constructed with a single span over the entire river between towers inside the established pier head lines in either state. No piers or other obstructions, either permanent or temporary in character, shall be constructed between said towers. A minimum clear headway at the center of the bridge of not less than 150 ft. above high water of spring tides is recommended. All plans and specifications must be submitted to the Secretary of War for approval before construction is commenced, and no changes in plan are to be made without such approval. General Casey does not approve of the appointment by the President of a commission of civil engineers to decide upon a safe length of span.

The most serious train accident of the week was a head collision, Feb. 17 on the Richmond & Danville R. R., near Proffit, Va., between a freight train and a work train. The flagman of the work train failed to do his duty. The engineer of one of the trains was killed.

A collision on the railway between Samara and Slatvousk, in eastern Russia, is reported to have caused the death of 13 persons.

An unfinished bridge span on the Chicago, Milwaukee & St. Paul R. R., near Ellis Junction, Wis., fell on Feb. 16. Fifteen workmen went down with the wreck; one man was killed and two were injured.——A wooden highway bridge over the Raritan River at New Brunswick, N. J., was burned on Feb. 18. The bridge is said to have been built over 70 years ago and to have cost originally $46,000.

A switching locomotive was at work in the yards of the Gulf, Colorado & Santa Fe Ry. at Temple, Tex., on Feb. 12, when the boiler exploded, fatally injuring four men who were in the cab.

The bursting of the main steam pipe on the German man-of-war "Brandenburg" on Feb. 16 resulted in the death of 41 men and the injury of many more. It is stated that the vessel had just been equipped with new boilers and was on her trial trip when the explosion occurred.——The head on a dead end of the main steam pipe in the electric railway power house at Ridge Ave. and Mt. Vernon St., Philadelphia, blew out on Feb. 12, seriously injuring five men.——A boiler explosion in a grain elevator, at Kelly, Ia., on Feb. 15, killed one man and injured two.

There are about 200,000 miles of telephone wire owned by the Western Union Telegraph and the American Bell Telephone companies, says the Chicago "Tribune," and the former company is said to own a four-fifths interest in these wires. The telephone has a monopoly in about 2,000 cities and towns in the United States, serving 175,000 subscribers and furnishing the means for 550,000,000 "talks" in 1893. The profits of the company are claimed to be $4,000,000 per year. At an estimated cost of $200 per mile for stringing a single telephone wire the plant of wire and poles alone is claimed to represent about $40,000,000. The Bell patent on the telephone receiver expired on Jan. 31, and it is now free to all dealers and users. Any one can now put up his own short line telephone; but he must still pay as before for the advantages of being connected with a system which can afford an extended service.

The .30 caliber magazine rifle adopted by the U. S. Army as a substitute for the old .45 caliber Springfield rifle is to be used with a bullet made of 87½ parts lead and 12½ parts tin. This bullet will be probably covered with a jacket of cupro-nickel steel as the German-silver jacket, used abroad now instead of copper, permits too much deformation of the bullet. Recent tests show that at 3 yds. range the German silver jacketed projectile will penetrate only 5.3 ins. into oak, and was much deformed, while with the steel jacket the bullet penetrated 19.5 to 24.2 ins. under similar conditions and was not deformed. The copper jacketed bullet was also much deformed The .45 caliber Springfield bullet gave only 3.2 ins. penetration at 50 yds. The "humane" purpose of this change in caliber and jacket metal is that the smaller caliber and harder casing of the projectile will disable rather than kill, as the ball will bore clean through a large bone, with comparatively little shattering or "shock." As opposed to this theory, late German experiments have been made with the casing removed from the end of the ball, with the deliberate intention that the lead should "mushroom" on striking and increase the effect on the victim. The tendency in all armies is now to reduce the caliber, though nothing smaller than .315 caliber has been yet used in actual warfare. Italy, Roumania and Holland have adopted a .256 caliber; our own navy has selected a .234 caliber, and gun-barrels as small as .197 caliber have actually been made. Our new army .30 caliber carries a ball weighing 220 grains, with a charge of about 37 grains of smokeless powder. For the benefit of some readers it should be stated that the caliber of small arms is here expressed in decimals of an inch.

A crystalline metamorphic limestone deposit, equal in beauty and quality to the finest statuary marble of Massa-Carrara, Italy, is reported upon by Mr. C. F. Z. Caracristi, C. E., as existing in unlimited quantity in the Department of Magdalena, Republic of Colombia. The stone is a great mass covering about 60 sq. miles and lies one mile from the Carribean Sea, a few miles from the Bay of Caira and one day's sail from the Panama Railway. It is white, gray and black in color, or varied with white, gray, black and pink, and withstands a crushing strain of 11,300 lbs. per sq. in. The engineer mentioned says that it can be transferred to New York for $3.65 per ton, and he estimates the cost of producing dimension stone at the quarry at 30 cts. gold per cu. ft. The Santa Marta railway passes within one-half mile of the quarries.

Irrigation conventions are to be held March 7 and 8 at Huron, S. Dak., and on March 21 and 22 at Omaha, Neb. The former has been called by Mr. C. S. Fassett, State Engineer of Irrigation, and will discuss the various phases of irrigation, especially artesian wells, which are so great a factor in the problem in South Dakota. The Omaha meeting will be interstate in character.

Among newly proposed canals in Germany are one from the Weimar to the Schwerin Lake, connecting with the Elbe Canal, and one connecting the Sliew, a firth of the Baltic, on the east coast of Sleswick, with the North Sea-Baltic Canal. The cost of the latter is estimated at $2,500,000, with a depth of 12 to 14 ft.

According to the last report of the Philadelphia Highway Bureau, that city now has 852.2 miles of paved streets, including 31 miles of macadamized turnpike. Within the year 1893 116.4 miles of streets were paved at a cost to the city of $3,500,000; 46 miles of paved streets were repaired and 15.3 miles of macadam roadway were built. Of this total mileage 50.4 miles were paved by the street railway companies at a cost to them of over $2,000,000. Of streets not occupied by railways, 23.6 miles were paved by the city with asphalt, Belgian block and brick, and 10 miles of small streets and alleys were paved with asphalt for sanitary purposes.

THE THIRD AVENUE CABLE RAILWAY, NEW YORK CITY.*

II.

(With inset.)

In our issue of Feb. 1 we illustrated and described the general arrangement of the curves and track crossings on the new Third Ave. cable railway, in New York city, and in this issue we continue the description of the more important structural features of the work with illustrations of the principal details of the cable transfer construction and the various special sheaves and sheave vaults, conduit construction, etc.

Regular Track Construction.—Many of the principal features of the regular track construction were illustrated in our issues of Aug. 9 and Dec. 13 and 20, 1891, and only such details will be given here as were not included in those articles.

In order not to disturb the large number of gas and water mains in the avenue any more than was necessary it was found desirable to make the cable conduit as shallow as was consistent with proper provision for the carrying sheaves, cables, grip jaws, etc. On the regular tangent track construction, therefore, the conduit was made only 2 ft. deep and 15 ins. wide in the clear inside and the slot rails were given a wide spread at the base in order to permit the jaws of the grip to ride well up toward the street surface. Although the conduit is but 2 ft. deep, the bottom is 10 ins. thick, and of course the excavation had to be carried somewhat deeper than this. Where the tracks were close together this excavation was carried across the width of both tracks and in most cases to a depth of 40 ins. Of course where the pulley vaults were located the excavation had to be correspondingly wider and deeper. The construction of the pulley vaults will be described later. The side walls of the conduit are 8 ins. thick. Both the side and the bottom walls were made of Portland cement concrete, the entire quantity of cement consumed in the work being 46,000 bbls.

The method of constructing the conduits and other trackwork varied somewhat on different portions of the line. On the section built by the first contractor, about 5½ miles, a steam stone crusher operated by a portable engine, was mounted on a car which was run along ahead of the work on the old tracks. The old paving blocks, consisting mostly of trap rock, which were removed, were crushed and used for making concrete. A mechanical concrete mixer was also used. On the later construction, however, the broken stone was purchased and delivered at the cross streets where the concrete was mixed by hand and delivered to the work in barrows and carts. Wooden forms covered with iron and shaped to conform to the inside of the conduit walls were used in laying the concrete.

Different styles of yokes were used for the tangent and curve construction weighing 475 lbs. and 500 lbs., respectively. The yokes are of cast iron and are placed 5 ft. apart on the tangent construction, making the number of yokes 1,056 per mile of single track. On that portion of the line built by the first contractor the yokes are supported on concrete sills 12 ins. square and 5 ft. long, sunk 46 ins. below the surface of the street, but on the later construction a continuous bed of concrete 6 ins. deep was used.

The track and slot rails are bolted to the yokes, breaking joints with each other, the joints of the track rails being suspended and those of the slot rails being supported on the yokes. The track and slot rails are also firmly braced and tied together by steel struts at points midway between the yokes. In order that the slot may be opened in case it becomes closed by the frost or the pressure of the surface traffic the slot rails are made slightly adjustable by filling the space between the rail and the base with bituminous concrete which can be melted out. The track rail is the one recommended by the State Railroad Commission and was illustrated in our issue of Aug. 9, 1890. It is of the semi-grooved girder type, 7 ins. deep and weighs 81 lbs. per yd. The joints are connected by 6-bolt fish plates. Both the track and slot rails are steel and were required by the specifications to contain not less than 30-100% nor more than 50-100% of carbon. The total weight of metal per lineal foot of tangent track is about 210 lbs., but of course at the curves the weight is much greater. Illustrations of the yokes, conduits, etc., were given in our issue of Dec. 13, 1890.

Regular Pulley Vaults.—Where the tracks were close together a double vault was used for the carrying pulleys. This has a manhole in the center between the two tracks which gives access to the pulleys on each side; that is for both tracks. They are spaced 35 ft. apart and are 5 ft. 2½ ins. deep and 4 ft. wide, and the manhole covers are 2½ × 2½ ft. They are constructed of brick with cement mortar, and where possible are individually connected with the sewer to allow for drainage. Where direct connection with the sewer was impossible the vaults were constructed to drain into the nearest vault having such direct connection. Where the tracks are separated as on the Bowery between Fourth St. and Grand St., a single pulley vault is provided for each track and the manholes are located outside the rails. The general construction of one of these vaults is shown in Fig. 1. The arrangement and support of the pulleys in the vaults were shown in our issue of Dec. 20, 1890. They are 16 ins. in diameter with 8-spokes.

Two pulleys are used on the curves, one of the spiral groove type, 33 ins. in diameter and the other a plain grooved pulley running above the spiral grooved pulley on the same shaft. They are placed 4¼ ft apart. These allow two cables to be carried around the curves without interfering with each other. The construction of these pulleys is shown in Fig. 2. They are mounted on gimbal bearings which permit of their adjustment in any direction. Details of these bearings will be given in another issue. To provide a passageway for the inspection of the pulleys in the long curve at Chatham Square, shown in our issue of Feb. 1, a brick subway 4 ft. wide and 5 ft. 11 ins. deep is constructed at the inside of the curves. The roof of this subway consists of I-beams and T-rails, upon which the manhole covers and paving rest.

The general details of the large terminal vaults and of the deflecting sheave vaults at the power stations will be given in our next issue.

Cable Transfer and Special Vaults.—In connection with the rope transfers and deflections there are a number of special vaults which have many points of interest in their construction. In Fig. 3 the general construction of the cable transfer at the "Times" Building, near the southern terminus of the line, is shown. At this point, as will be remembered, the car which has been using the slow cable down from Bayard St. and around the Post-office loop changes to the fast cable for the uptown trip. The arrangement of the cables will be clearly seen from the drawing. There are six vaults, each with a special arrangement of pulleys required for this transfer.

In Fig. 4 are shown the arrangement of the pulleys and their supports in vault No. 1, where the cables going uptown enter the transfer pit. Fig. 5 shows the arrangement of the elevating sheaves and the pulleys in vault No. 3, and Fig. 6 the details of the pulleys and their supports in vault No. 5 where the cables leave the transfer pit. Fig. 7 shows the construction of the pivotal, automatic elevating sheaves used to bring the cable into position for the grip at the power stations and cable crossings as well as at this point. Fig. 8 shows the special pulley vault for the west track at the 125th St. cable crossing, and Fig. 9 the details of construction of one of the spiral pulleys used here.

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THE PANTHER CREEK VIADUCT.

By M. S. Knight, Resident Engineer.

The Wilkes-Barre & Eastern R. R. runs from Wilkes-Barre to Stroudsburg, Pa., where it connects with the New York, Susquehanna & Western R. R. The total length of the road is 65 miles. The locating surveys were made during the winter and spring of 1891-92, Mr. I. E. Hartwell being the chief engineer, and the road was completed about the middle of October, 1893. The work of construction was done by the Wilkes-Barre & Hudson River Improvement Co., with Col. T. M. R. Talcott as chief engineer, up to Feb. 1, 1893, when he was succeeded by Mr. Robert L. Harris, M. Am. Soc. C. E., of New York city.

The chief feature of engineering interest on this line is the viaduct built over Panther Creek hollow to save the mile of distance necessary to get around the head of the ravine. The cost was about $75,000 more than the abandoned roundabout route. The substructure of this viaduct was built during the spring of 1893 by "day work" for the improvement company, from designs and under direction of the chief engineer. The metal superstructure was designed, manufactured and erected by the Edge Moor Bridge Works, of Wilmington, Del.; the design, manufacture and erection being inspected by R. W. Hildreth & Co., of New York city. The length of the viaduct is 1,650 ft. end to end of girders and it is composed of plate girders, 7 ft. c. to c., resting on steel towers. There are 30 iron plate girder spans, each 30 ft. long, one 60 ft., one 40 ft. and ten 65 ft. long. The height from the creek channel to the base of rail is 161 ft. and from the top of masonry to the base of rail is 154 ft. 6½ ins. There are 20 supporting towers made up of steel Z-bar columns with rigid bracing throughout. All the towers rest upon concrete piers with 18-in. thick cap stones, varying from 4 ft. to 4½ ft. square, of red sandstone from quarries near Wilkes-Barre. The anchor bolts for the tower feet were built into the piers.

The concrete in these piers was made of one part Alsen's Portland cement, two parts sand, and four parts broken stone. The stone was broken to pass through a 2-in. ring. The sand and cement was well mixed dry, and the stone, thoroughly wet, was incorporated therewith, and only enough water added by sprinkling to uniformly dampen the mass. This was put in place as quickly as possible, in layers 8 ins. thick, and thoroughly rammed with 35-lb. metal rammers. In this manner two courses, one immediately following the other, were put in each day. The services of Irving A. Hodge, a contractor of much experience in the manufacture of concrete, were secured for the superintending of the construction of the substructure.

Test borings were made wherever necessary to determine the nature of the foundations, and in making these, we discovered that under bents 25 to 29 inclusive, there was a bed of quicksand, from 6 ft. to 12 ft. thick, and from 10 ft. to 20 ft. below the surface. The material overlying the quicksand was usually coarse sand and gravel. The foundations of the first 15 bents are built mostly on the bedrock, at a depth of about 7 ft. from the surface, having 10-ft. square bases from 2 ft. to 4 ft. thick, with 9-ft., 8-ft. and 6-ft. square courses, each 2 ft. thick, following to the cap stones which are 4 ft. square. The pedestals for bents 16 to 22 and 33 to 35, inclusive, have 11 × 11-ft. bases from 2 ft. to 5 ft. thick with 10-ft., 9-ft. and 7-ft. square courses, each 2 ft. thick, following to the cap stones, which are 4½ ft. square. The pedestals for bents 23 and 24 have bases 12 ft. square, otherwise they are the same as the preceding ones. The pedestals for bents over the quicksand, 25 to 29, inclusive, have bases 16 ft. square and 3 ft. thick with 11-ft., 9-ft. and 7-ft. square courses, each 2 ft. thick, with cap stones 4½ ft. square. The excavations for these were made from 5 ft. to 6 ft. below surface and the pedestals rest upon from 6 ft. to 16 ft. of gravel overlying the quicksand.

The foundations for bents 30 to 41, inclusive, are on bedrock. The anchor bolts are 5 ft. 10 ins. long for the 20 shorter bents, and 7 ft. 10 ins. long for the remaining 21 bents. These bolts, being adjusted to a cast iron spider by means of two nuts, were placed in position, as the concrete reached the proper elevation, and a piece of 2-in. pipe 2 ft. long dropped over each bolt; as the concrete was put into place and began to set these pipes were loosened and raised for the next course, thus leaving a space of about ½ in. all around the anchor bolt, which was found to be very convenient in adjusting the bolts to the feet of the towers. This space was afterward filled with Portland cement grout. On completion, and after the frames holding the concrete in place, were taken away, good material was rammed in around the pedestals and graded up to the top of the cap stone, sloping from it in each case for drainage. The creek has a paved and grouted channel 35 ft. wide, with side walls 6½ ft. high extending 60 ft. each side of center line.

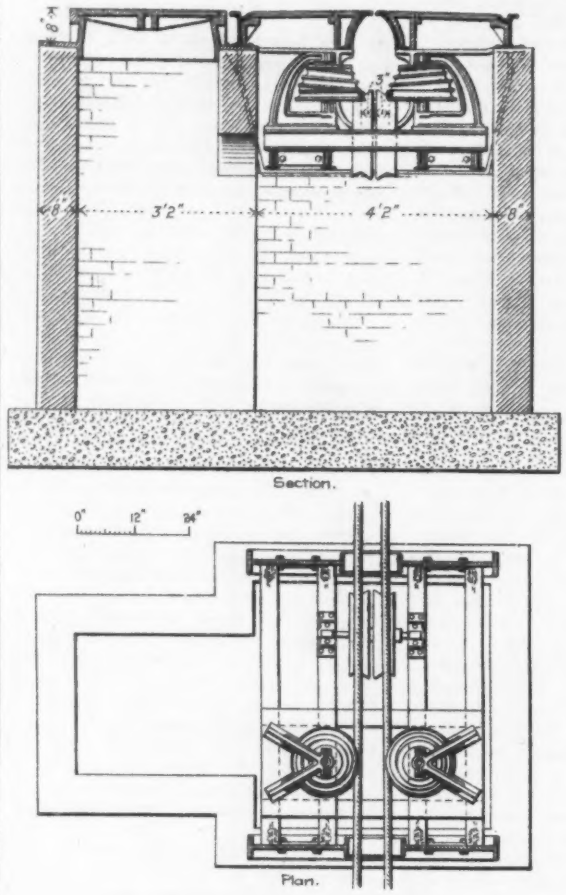


FIG. 8. SPECIAL PULLEY VAULT AT 125th ST. CROSSING.

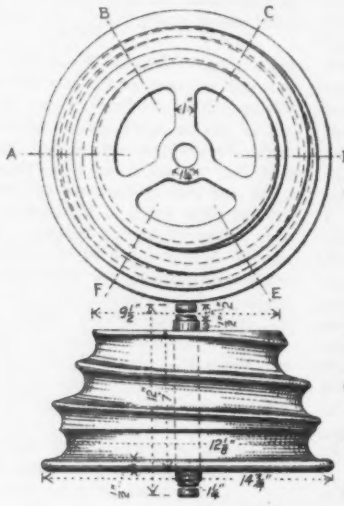


FIG. 9. CONSTRUCTION OF SPIRAL PULLEY FOR 125th ST. CROSSING.

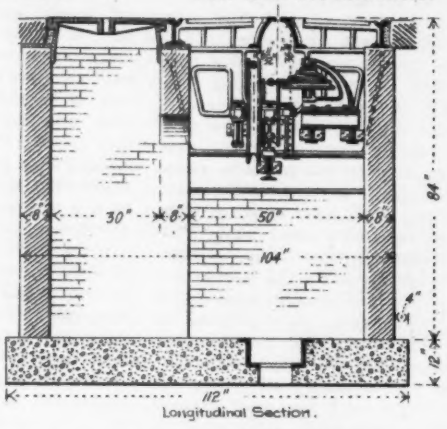


FIG. 6. SPECIAL PULLEY VAULT No. 5, ROPE TRANSFER PIT.

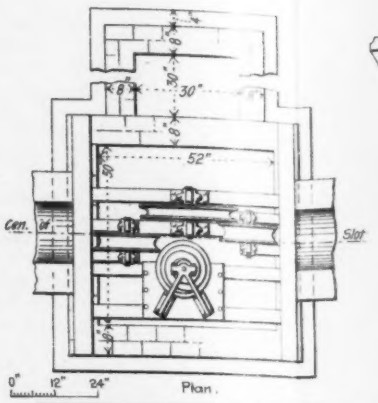
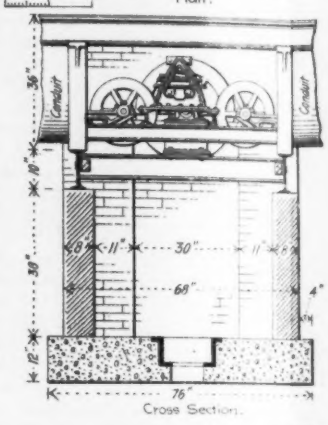


FIG.



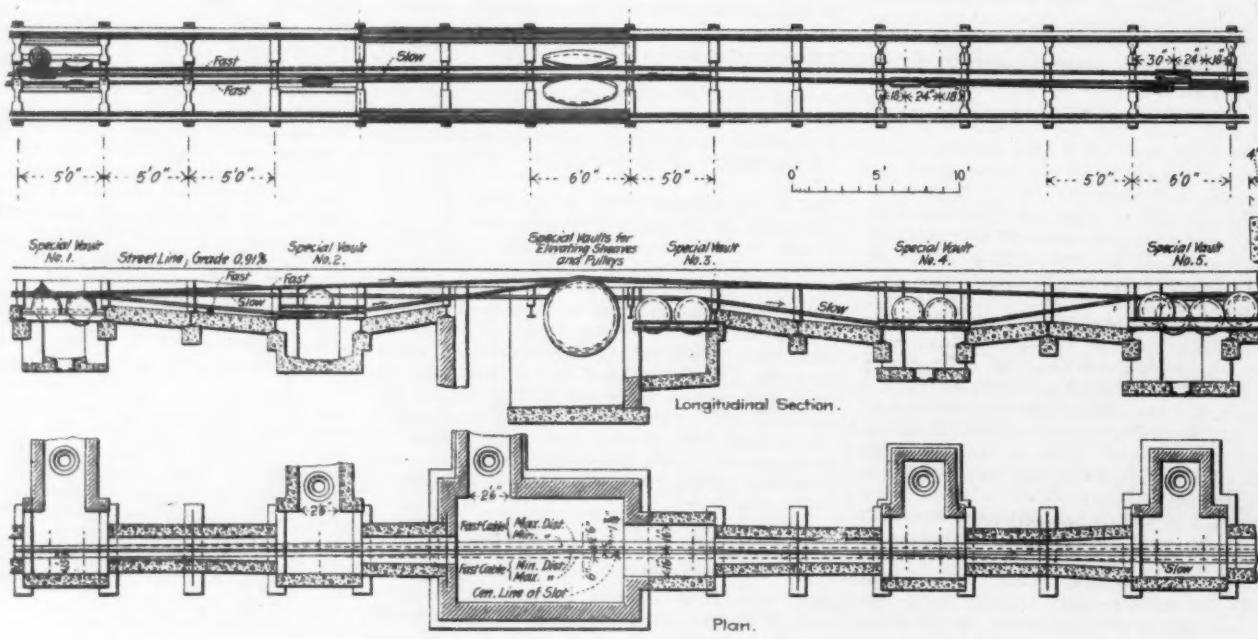


FIG. 3. CABLE TRANSFER PIT NEAR "TIMES" BUILDING.

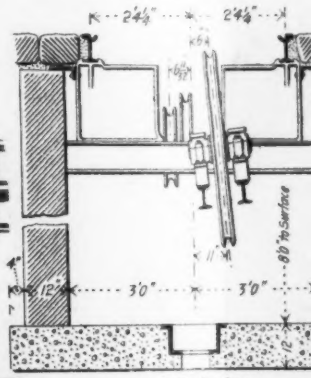


FIG. 5.

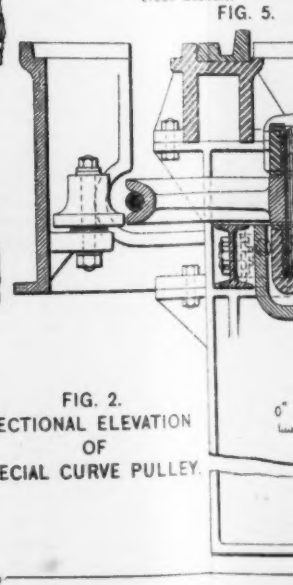


FIG. 2. SECTIONAL ELEVATION OF SPECIAL CURVE PULLEY.

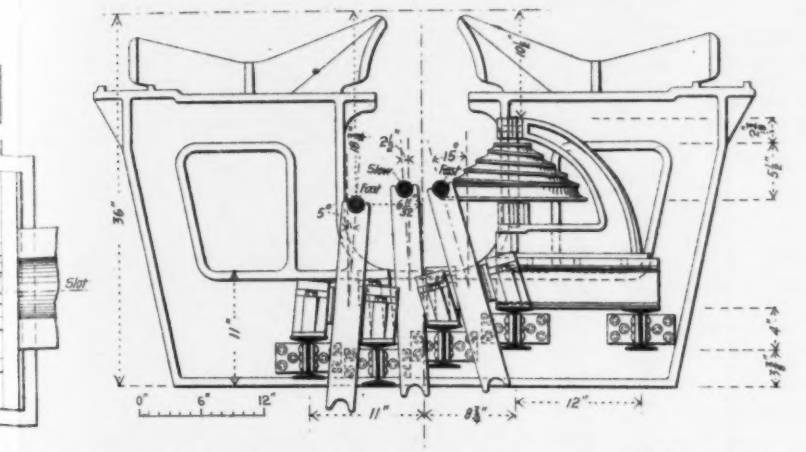


FIG. 4. SPECIAL YOKE AND PULLEYS FOR VAULT No. 1, ROPE TRANSFER PIT.

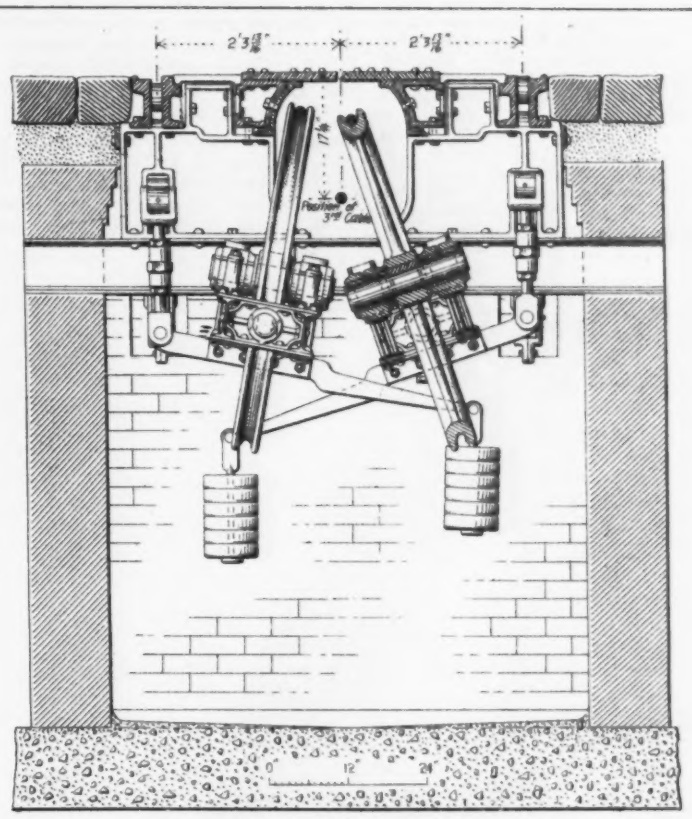


FIG. 7. PIVOTAL ELEVATING SHEAVE VAULT.

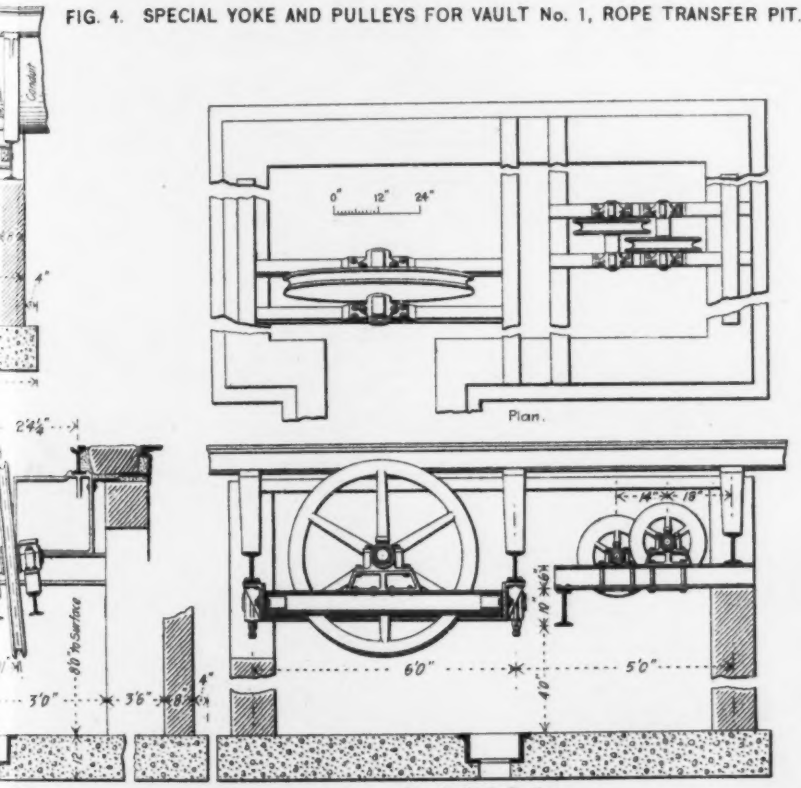


FIG. 5. ELEVATING SHEAVE VAULT ROPE TRANSFER PIT.

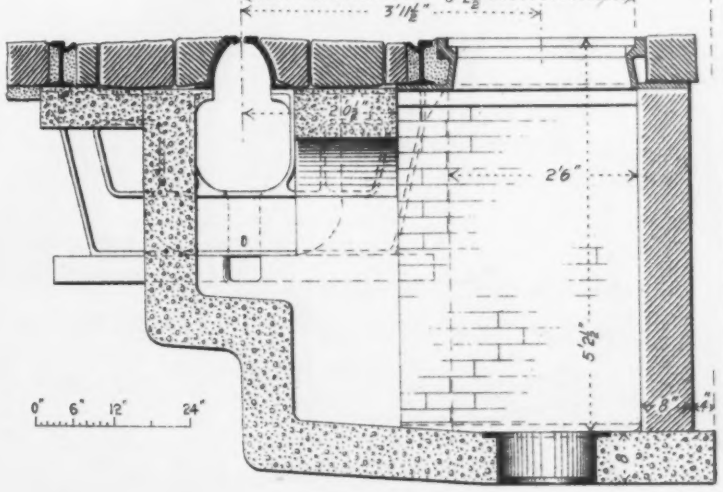
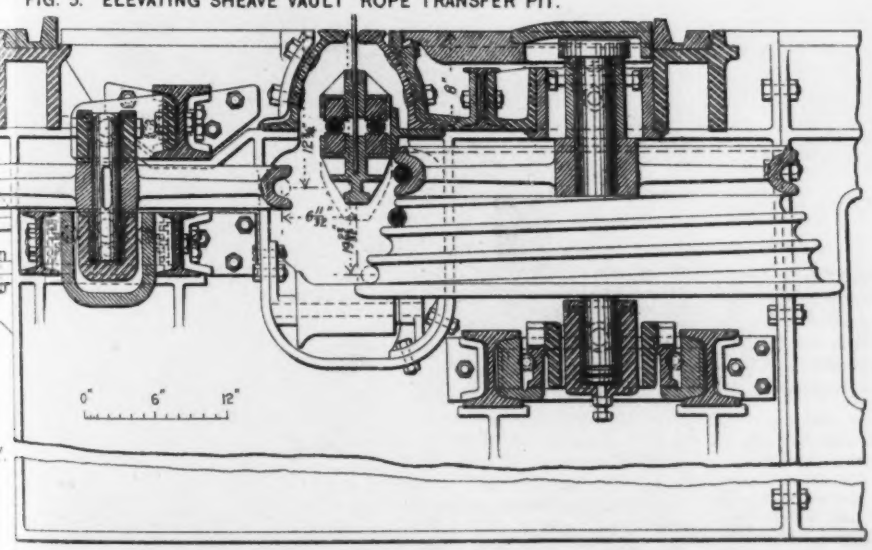


FIG. 1. SINGLE VAULT FOR CARRYING PULLEY.



THIRD AVE. CABLE RAILWAY; CABLE TRANSFER AND SPECIAL PULLEY VAULT CONSTRUCTION.

J. H. Robertson, Superintendent.

A. H. Lighthall, Chief Engineer.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

The total amount of concrete used in the foundations is 2,353 cu. yds., and it was put in place from April 11, 1893, to June 24, 1893. During the progress of the work, we made 6-in. cubes of the concrete used in each pier. On each side of these cubes was marked the date of manufacture and the number of the pier from which it was taken. We afterward sent a number of these to the U. S. Arsenal, at Watertown, Mass., to be tested for compression with the results shown in the accompanying table:

Tests of Concrete Cubes by Compression Made at U. S. Arsenal, Watertown, Mass., July 21, 1893.

(Compressed surfaces faced with plaster of Paris to secure level bearings in the testing machine.)

No. of test.	Age, days.	Height, ins.	Area compressed, sq. ins.	First crack, lbs.	Total stress, lbs.	Lbs., per sq. in.
1	88	5.98	35.76	87,800	87,800	2 457
2	88	5.98	36 36	58,800	76 200	2,096
3	82	5.98	36 90	59,500	99 800	2.705
4	82	5.95	36 90	57,500	98,450	2,668
5	75	5.94	36 48	80,600	81,410	2,232
6	77	5.94	36.23	97,270	98,940	2,731
7	65	5.91	36.54	101,800	116,109	3,177
8	65	5.92	35.82	86,200	88,100	2,459
9	62	5.90	35 81	80 900	82,400	2,302
10	69	5.90	35.39	59,100	59,100	1,670
11	51	5.95	36.18	93,620	94,620	2,588
12	51	5.90	35 82	81,600	84,700	2,365
13	46	5.93	36.11	76,900	76,900	2,132
14	44	5.85	35.63	61,780	61,780	1,734
15	37	5.94	36.48	68,800	73,400	2,012
16	36	5.85	35 99	69,200	69,200	1,923
17	31	5.90	36.11	75,500	75,500	2 091
18	31	5.87	35.93	62.490	62 490	1,739
19	27	5.80	36.05	66,100	66,140	1,835
20	27	5.94	35.45	59,100	59,100	1,667

The great strength of the concrete shown in the table is doubtless due, not only to the excellent quality of the cement, but also to the care used in inspection of all materials, the specified mode of mixing and the thoroughness of manipulation. On examining the fragments after testing, it was observed that the cubes standing the least test were usually poorly rammed.

The erection of the viaduct was superintended by John Kane, assisted by James Hedrick as general foreman, and was carried on without the use of falseworks. The work was begun on June 28, and the erection completed without loss of life or limb on Aug. 3, 1893. The different members fitted so closely that the end of the last girders came to within 1-16 in. of the engineer's marks on the bridge seat. Twenty-eight days, exclusive of delays occasioned by non-delivery of iron and inclement weather, was the actual time consumed in the erection of 1,861,607 lbs. of iron, the weight of the viaduct, 66,485 lbs., being the average amount raised per day with an average of about 40 men all told. The following description of the traveler is given by H. F. Lafland, Assistant Engineer of Erection for the Edge Moor Bridge Works:

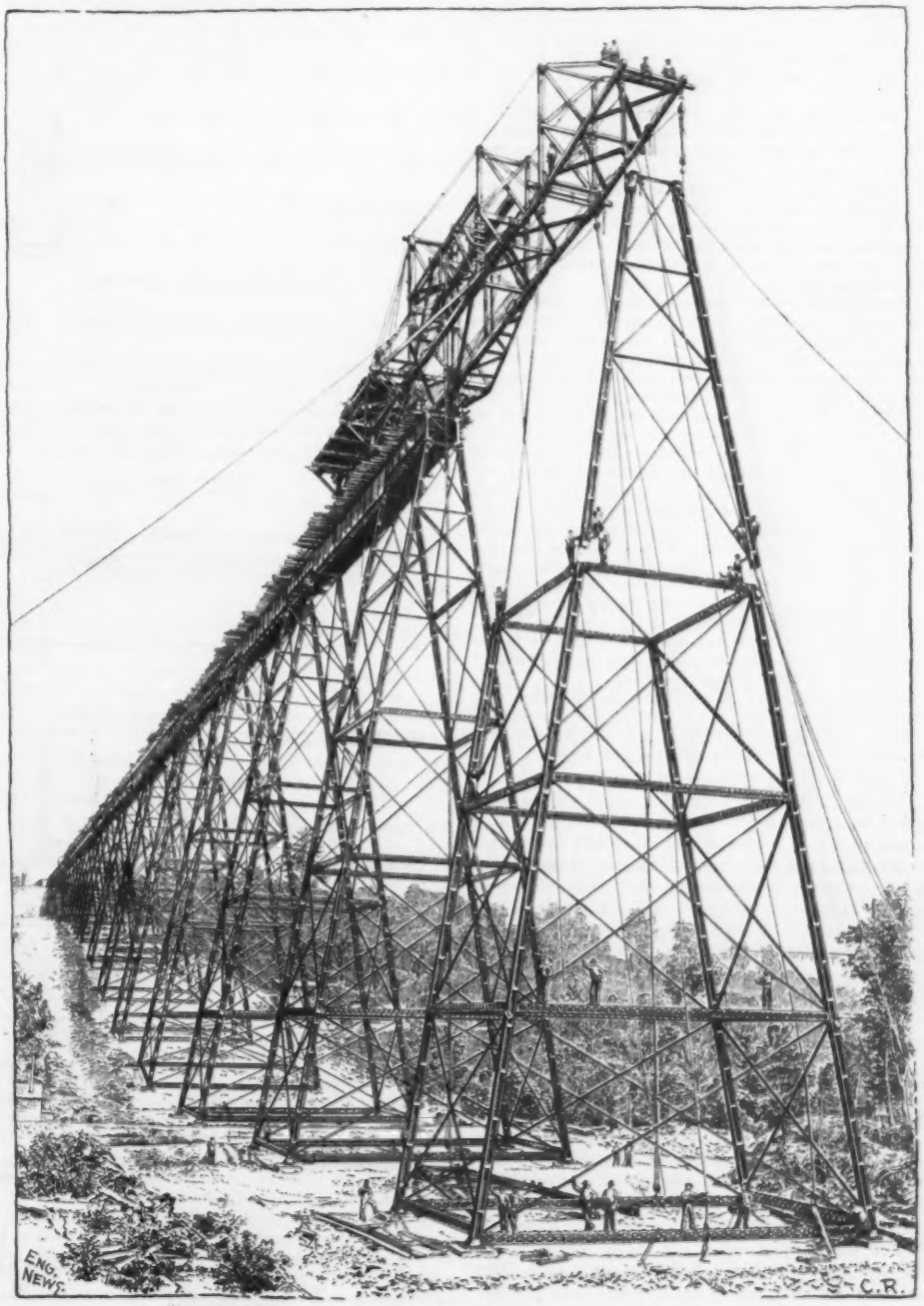
"An overhanging traveler, built of Oregon fir, was used. The extreme length out to out was 162 ft. 4½ ins. The length of the overhanging portion was 101 ft. The weight of traveler with rigging ready for use was 54 tons, and it was designed to handle, exclusive of its own weight, 7 tons at the extreme point and 10 tons 30 ft. back from the end. It was carried on eight wheels 20 ins. in diameter, four of these being under the main bent of the traveler, two on each side. The height from top of rail to center of pin in the main bent was 43 ft. 3½ ins. and the width of traveler 10 ft. center to center. The counterweight used was 36,000 lbs. with its center of gravity placed 45 ft. back from the main bent. All of the iron was run out from the top, lowered by means of a trolley to the ground, and raised by the overhanging booms to position.

These booms consisted of 8×16-in. timbers reinforced by 4×16-in. timbers bolted on each side of the 8×16-in. timbers. The longest stick of timber used in the boom was 8×16 ins.×70 ft. 3 ins. long. The concentration under the forward wheels of the traveler when lifting its maximum weight was 76 tons. The rails on which the traveler ran were carried by 8×8-in. crossties 12 ft. long, and when the heaviest lifting was being done four crossties made of 8-in. channels were used under the forward wheels. The traveler was braced laterally by means of outriggers for 40 ft. of the overhanging portion, and for the other 60 ft. ordinary Howe truss bracing was used. The traveler was easily moved and was very stable against heavy winds."

Mr. Robert L. Harris, No. 1 Broadway, New York, was Chief Engineer of the improvement company during the construction of this work; Mr. R. B. Wick was Division Engineer; Mr. M. S. Knight, Resident Engineer in charge; and Mr. A. G. Raught, Assistant Resident Engineer.

WATER TUBE BOILERS FOR THE ST. LOUIS WATER-WORKS.

An important contract for water tube boilers was awarded by the city of St. Louis on Feb. 10. The contract has excited much controversy and has developed some points of general interest. We therefore give a brief review of the circumstances.



PANTHER CREEK VIADUCT, WILKES-BARRE & EASTERN R. R., PENNSYLVANIA. Robert L. Harris, Chief Engineer. Edge Moor Bridge Works, Contractors

The specifications called for six horizontal water tube boilers complete with foundations, settings and all attachments ready for firing, the contractor furnishing and erecting all material from the bottom of the foundations to the smokestack. The following is condensed from the specifications:

Design.—The boilers to be designed and built with special reference to easy access for cleaning and repairing both internal and external surfaces, to use the natural draft, and to have a factor of safety of 6 on minimum sections under a steam pressure of 140 lbs. Each boiler shall be designed and built to give an evaporative capacity of 9,000 lbs. of water per hour, from a temperature of 212° F., into dry steam of 70 lbs. gage pressure (or equivalent of this capacity). The boilers shall utilize at least 65% of the calorific value of the coal when running at the above capacity. The boilers to be capable of being forced to a capacity 25% in excess of the above specified capacity without loss of efficiency. The boilers to be provided with plain furnaces and straight grates for burning southern Illinois coal, and to be tested with these furnaces and grates. The coal used to be southern Illinois coal of a calorific power of not less than 10,500 British thermal units per pound of coal. The steam generated by the boilers under the above conditions shall contain not more than 1% of moisture. The city of St. Louis will pay a premium on each boiler at the rate of $250 for each 1% of efficiency shown on test in excess of 65%, and will retain from final estimate at the same rate for each 1% which each boiler fails below 65%.

The boilers are to be set in three independent batteries with 6-ft. passageways between. The total floor space occupied, including passageways, shall not exceed 90 × 28 ft. Each boiler must have an 8-in. angle valve at its junction with the main steam pipe, two 3½-in. safety valves, and all necessary valves, cocks, steam gages, water glass gages, etc. The brick settings must have hollow walls and the boilers must be so supported as to permit free expansion and contraction.

Fittings and Appurtenances.—The contractor shall furnish all valves, gages, wrenches, firing tools necessary for the operation of the boilers. Each boiler to have two Bailey safety copper cap fusible plugs or other

safety plugs equally good. Steam valves above 6 ins. in diameter shall have steel stems with phosphor bronze nuts. The breechings and main smoke flue must be not less than 0.128 in. thick, with air tight joints, suitable dampers and provision for free expansion and contraction. The main flue, breechings, steam drums and all parts of boiler and pipes not covered by brickwork must be protected by at least 1½ ins. of asbestos or magnesia covering. An underground smoke flue of brick laid in cement mortar and concrete may be substituted for the iron flue at the contractors' option.

Materials.—All plates to be of steel, stamped with the maker's name and the tensile strength, to have a tensile strength between 55,000 and 62,000 lbs. per sq. in., an elastic limit of at least 30,000 lbs. and at least 24% elongation in 8 ins. Specimens, after being heated to a cherry-red and plunged into water at 70° F., must bend double and close down flat without showing signs of fracture.

Wrought iron for bolts, nuts and other purposes to have at least 52,000 lbs. ultimate strength, 26,000 lbs. elastic limit and 18% elongation in 4 ins. Cast iron must have not less than 22,000 lbs. ultimate strength, and test bars 2 ins. × 1 in. when placed on supports 24 ins. apart and loaded at the center must support a load of 2,200 lbs. and deflect not less than 0.35 in. before breaking. Steel castings must have 65,000 to 75,000 lbs. tensile strength, 25,000 lbs. elastic limit and 15% elongation in 2 ins.

Workmanship.—All holes in castings for bolts, rivets, etc., must be drilled. Rivet holes in plates may be punched, but the drift pin must not be used, any inaccuracies in alinement being corrected by reaming. All seams must be calked on both sides wherever accessible and a round nosed tool must be used.

Testing.—The test for capacity and efficiency will be made by experts selected by the water commissioner and paid by the city. A sufficient number of boilers shall be under fire during the test to give a draft of not less than 7-10 in. of water. Results to be figured in accordance with the established rules of the American Society of Mechanical Engineers. The contractor must furnish firemen during all tests at his own expense, and will be given opportunitty to make necessary preliminary trials before submitting boilers for formal tests. The coal burned during the tests will be southern Illinois coal, furnished by the city of St. Louis, and delivered to the contractor on charging cars in the boiler-house in the same manner as coal is now handled at the Bissell's Point pumping station.

The boilers shall be given a hydraulic pressure test of 210 lbs. per sq. in. in the shop at the contractor's expense, and shall be water tight at that pressure. They shall then be thoroughly cleaned, scraped, dried and painted outside with two coats of linseed oil.

Computing the capacity of the boilers by the commonly used standard (1 HP. = 30 lbs. of water evaporated per hour from feed at 100° to steam at 70 lbs. gage pressure), we find that according to the contract requirements each boiler is rated at 270 HP., or 1,620 HP. for the whole plant. Proposals received under the specification were opened Dec. 22 and were as follows. We have added the column showing what each bid is equivalent to per horse power:

Bidder.	Amount.	Price per HP.
National Water Tube Boiler Co....	$19,868	$12.26
Heine Steam Boiler Co.....	24,550	15.15
Link Belt Machinery Co	29,500	18.21
Babcock & Wilcox Co.....	32,250	19.91
Campbell & Zell Co.....	32,500	20.06
Edge Moor Iron Co. .....×..	35,300	21.79

Remembering that these bids include setting and all appurtenances, it will be seen that they are phenomenally low, and referring to the specifications it is evident that the bidders are looking for their profit to the clause of the contract which allows a premium of $250 per boiler for each 1% efficiency above 65% which the boilers realize. The coal used is stated to contain "not less than" 10,500 B. T. U. per lb. Now 65% of this quantity is 6,825 B. T. U., and dividing by 966, the latent heat of evaporation, we see that the specified efficiency of 65% will be equivalent to an evaporation of 7.07 lbs. of water from and at 212° per lb. of coal. This is certainly low, even for southern Illinois coal. With careful firing (and the contractor furnishes his own men) an evaporation of at least 8 lbs. ought to be secured, which would be equivalent to an efficiency of 73½%. An increase in efficiency of 8½% over the 65% required by the contract would mean a premium of $12,750, or nearly $8 per HP.

At first sight the premium offered, amounting to 92 cts. per HP. for each increase in efficiency, may seem excessive, but a computation shows that the fuel economy secure will be worth much more than this to the city. Suppose the boiler plant runs 10 hours a day throughout the year, burning 4 lbs. of coal per hour per nominal horse power of boiler, the coal costing $2 per ton, including handling, firing and disposal of ashes. The cost of fuel will then be in round numbers about $15 per nominal horse power per annum. An increase of 1% in efficiency will mean a saving of nearly 1½% in fuel, or about 22 cts. per annum per horse power. Now 22 is 24% of 92; hence the apparently large premium which the city offers for an increase in efficiency

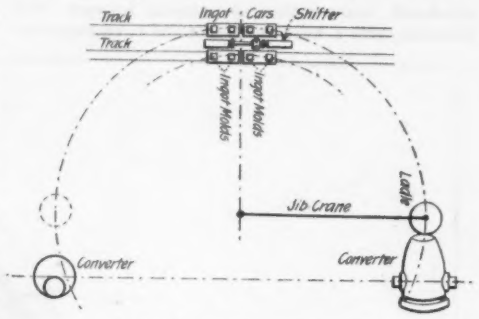


Fig. 1. General Arrangement.

is really an investment which will return it about 24% interest.

As stated at the outset, there was great controversy over this contract. The makers of fire tube boilers in St. Louis opposed the restriction of bidders to the water tube type alone, and Col. E. D. Meier, of the Heine Safety Boiler Co., opposed the award of the contract to the National Co. on account of its use of cast iron headers. In replying to these objectors Mr. Edward Flad, M. Am. Soc. M. E., who represented the National Co., said that many boilers with cast iron headers carried 100 to 200 lbs. pressure and that of all the 15,000 cast iron headers put into boilers built by the National Co. not one had ever been broken. Mr. W. M. Green, Chicago representative of the Babcock & Wilcox Co., defended the use of cast iron headers, and said that Babcock & Wilcox boilers with cast headers have been working for years at a pressure of 200 lbs. per sq. in. The company put wrought iron headers in the boiler plant of the Oliver Steel Plow Works, at South Bend, Ind., but afterward replaced them with cast iron headers at the request of the company's own engineers. A board of experts in the city of Paris after thorough investigation selected cast iron headers for a municipal contract as being superior to headers of wrought iron or steel. The only foreign government which requires the use of wrought iron headers is Belgium.

At a meeting of the City Council on Feb. 10 the contract was awarded to the lowest bidder—the National Water Tube Boiler Co., of New Brunswick, N. J., by a vote of 7 to 6.

A HYDRAULIC SHIFTING DEVICE FOR INGOT CARS.

We illustrate in the accompanying cuts a hydraulic ingot car shifting device designed by Mr. A. Bechker, of Pittsburg, Pa., for use in steel works. As is well known, the old form of casting pit has been done away with in several European steel works and in one large works at least in this country, it being replaced by an arrangement for casting the ingots in molds carried on cars. These cars are made up in trains of from four to six single-mold cars, or two to three two-mold cars, and are hauled by small locomotives. The shifting of the cars to bring the molds successively under the ladle is done by the locomotive. As can be easily understood, the cars are apt to be moved a little too far or not far enough to have the metal teemed into the center of the mold, and thus some trouble and delay arise in properly adjusting them. It is to obviate this difficulty that the shifting device which we illustrate has been designed.

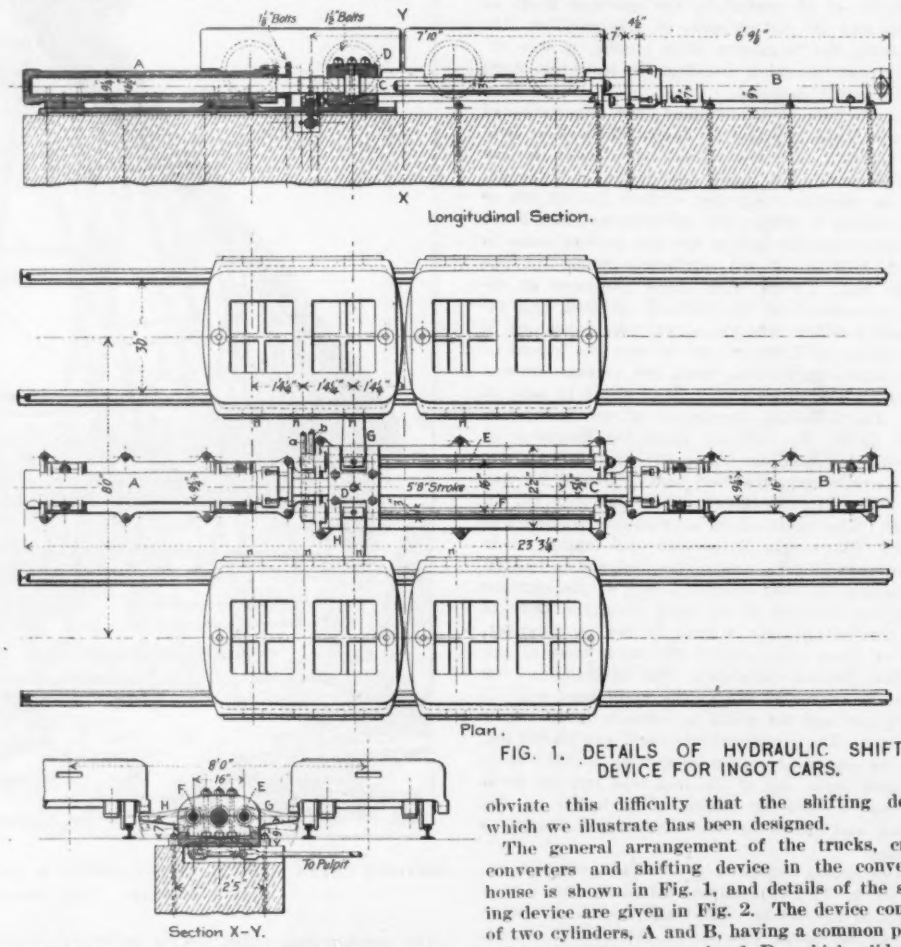


FIG. 1. DETAILS OF HYDRAULIC SHIFTING DEVICE FOR INGOT CARS.

The general arrangement of the trucks, crane, converters and shifting device in the converter-house is shown in Fig. 1, and details of the shifting device are given in Fig. 2. The device consists of two cylinders, A and B, having a common piston rod C carrying a crosshead D, which slides on two rods, E and F. The shifting arms, G and H, slide on feathers on these rods and have bearings in the crosshead. The rods can be given a partial revolution by the levers, a, b, from the pulpit and thus raise or lower the shifting arms, as shown in the section XY. When raised the arms engage with the notches, n, n, on the cars and shift them one way or another according as the water is let into the one or the other of the cylinders. Further details of the construction and operation will be seen from the drawings. It may be stated, however, that the cylinders are of cast steel and the water pressure is 750 lbs. per sq. in.

The advantage of this device over the usual locomotive is quite evident provided it will work successfully. The chief objection to the method of casting ingots on cars has been that any spill of molten steel was likely to block the cars and track and occasion delay. In regard to this point Mr. Henry M. Howe, in "The Metallurgy of Steel," says:

> The fouling of a single wheel or of the truck would detain a whole train of cars, and temporarily paralyze the establishment. Opinions are divided as to the detention which would be thus caused in actual rapid work. It is stated that this system has been used in some European works without serious trouble. But in these works the output is relatively small, and it seems to me that leaky nozzles and molds are still common enough to form a serious menace, when such extreme rapidity of working as is common in this country is sought, and where every delay of even a few seconds is to be guarded against.

The hydraulic machinery illustrated would seem to be especially liable to such accidents as are noted by Mr. Howe, but it is claimed that it can be covered with a protecting shield. With a single track having the shifter placed at one side there would be less liability of obstruction. Mr. Bechker states, however, that a similar device has been successfully used at the Duquesne Steel Works, of the Carnegie Co. The shifter illustrated is to be put in operation at the new steel works of the Ohio Steel Co., at Youngstown, O., now being constructed under the direction of Mr. Julian Kennedy, M. Am. Inst. M. E.

ERRATA IN "CLEANING AND SEWERAGE OF CITIES."

In the first edition of Baumeister's "Cleaning and Sewerage of Cities," published in 1891, we have noted the following errata, and if readers of the book have discovered other errors than these we shall be very much obliged if they will point them out to us:

Errata.

Make table at bottom of page 16 read as follows:

Population per sq. mile.	Heavy ground.	Impervious ground.
16,000	21.5%	25%
20,500	25.0%	33%
25,600	27.5%	43%
32,000	28.0%	55%

Page 31, 7 lines from top. For "in 5 pieces" read "in 4 pieces."

Page 35, 5 lines from bottom. For "grades" read "classes."

Page 43, first line. For "over 1 ft." read "over 2 ft." The next sentence should read as follows: "The cast iron covers rest on crowns of cast iron or dressed stone, and are so arranged that wood or cement can be laid on them, offering no obstacle to traffic." In the last line, "slight" should be "slightly."

Page 48, 6 lines from bottom. For "in Figs. 43 and 47" read "in Figs. 43 and 44."

Page 56, 6 lines from top. For "frem" read "from."

Page 69, 19 lines from top. For "larger" read "large."

Page 74, 4 lines from top. For "Roger Field" read "Rogers Field."

Page 76, 2 lines from top. For "pipe p" read "pipe f."

Page 81, 4 lines from bottom. The last complete sentence on the page should read: "These means of ventilation are rarely all present at the same place; generally the house drains are cut off by a running trap."

Page 103, 6 lines from top. The sentence beginning on this line should read: "Several English cities—Oxford, Windsor, Reading and others—were so sewered before Memphis."

Page 103, 8 lines from top. For "Goettinger" read "Goettingen."

Page 129, 6 lines from top. For "275" read "28."

Page 128. In Fig. 133 a letter "a" should be inserted at the lower right hand corner of the cut against the pipe running diagonally toward the entrance to the precipitating tanks. A letter "b" should be placed against the two pipes running to the same place.

Page 133, 6 lines from top. For "Fig. 177" read "Fig. 133."

Page 133, 8 lines from top. For "v" read "b."

Page 139. Make the caption of Fig. 141 read "Precipitating Tanks, Dortmund."

Page 143, 3 lines from top. For "time" read "lime."

Page 165, 12 lines from top. For "as" read "are."

Page 167, first line. The sentence beginning "The average annual income" should continue "from the city farms, of which 42% are now supplied with sewage ranges from $8 to $14 an acre net, or from $13 to $40 gross."

Page 170, 19 lines from bottom. For "sanitary water" read "domestic wastes."

Page 170, 5 lines from top. For "sanitary water" read "domestic wastes."

Page 178, 7 lines from top. For "pubilc" read "public."

Page 180, 3 lines from top. For "2,510" read "2,000."

Page 183, 10 lines from bottom. For "drys" read "dries."

Page 184, 5 lines from top. For "cleaning" read "keeping."

Page 192, 6 lines from bottom. For "sidewalks" read "sidewalk."

Page 193, 8 lines from bottom. For "142" read "147."

Page 194, 7 lines from top. For "three" read "two."

Page 197, 21 lines from top. For "1 per mile" read "0.1 per cent."

Page 197, table at bottom of page. Make "Nitrogen" head last two columns.

Page 210, 18 lines from bottom. For "in Fig. 177" read "in Fig. 178."

Page 211, 2 lines from top. For "in Fig. 178" read "in Fig. 177."

Page 232. Change the captions of Figs. 188 and 189.

For "sanitary" read "domestic" in the following places: Page 47, 17 lines from bottom; page 51, 3 lines from bottom; page 94, 6 lines from bottom; page 95, 8 lines from bottom; page 98, lines 2, 4, 7, 23 and 27; page 100, 9 and 4 lines from bottom; page 101, line 15; page 102, lines 15, 22, 25 and 37; page 103, lines 16, 22, 25, 33, 34 and 39; page 105, 11 and 5 lines from bottom; page 109, lines 5, 8, 13, 31 and 35; page 122, line 5; page 155, 23 lines from top; page 157, 7 lines from bottom; page 223, 11 lines from bottom.

DRIVEN WELLS ON THE PLAINFIELD WATER SUPPLY SYSTEM.*

Plainfield is located in a comparatively level valley, which is only 7 miles long and from ¾ to 2 miles wide. This valley is fairly well wooded and slopes gently to the westward. It is divided by a small stream running to the southwest, having several short tributaries, and together they furnish excellent drainage for the city. The soil consists of strata of sand, clay and gravel, rock being encountered at a considerable depth. Water has always been obtained for domestic use by driving pipe wells from 20 to 80 ft. and attaching pumps directly to them. For fire supply, large brick curbs have been sunk 15 to 20 ft. into the gravel, and give an abundant flow. With the increasing population and no sewerage system, these wells became a source of danger to health, but nothing has been accomplished during twenty years toward an improvement in these conditions, beyond the organization of a water company. In 1890 active measures were inaugurated; tests and examinations were made, and, finally, pipe wells sunk about 1½ miles from the city, in a soil where the upper clay stratum was 30 ft. or more thick, and underlaid by a coarse water-bearing gravel. This spot was selected on account of being higher than the city, convenient, and free from probable contamination. The quantity of water obtained from ten wells by eight hours' daily consecutive pumping, during two weeks of observation, was at the rate of from 2,000,000 to 2,250,000 gallons in 24 hours. The cast heads to the wells were of such construction as to transform each water tube into practically an open well, thus giving atmospheric pressure free play, rather than forcing its action through the earth, as in systems where a single tube is used. The most distant well is 500 ft. from the pumps and shows very strikingly by the vacuum at the well head and increased vacuum at the pump the effect of long suction and of friction in the main.

Tests from four 2-in. pipe test wells were made during several months by the writer; each pipe had a balanced float gage which indicated the rise and fall of the water. The test wells were very sensitive to draft on the main wells when pumping was going on, the nearest main wells being 150 ft. distant. Observation showed that in about 1,900 ft. the underground water level fell to the westward about 3 ft., which is about the grade of the surface of the ground. This showed conclusively that there was no danger of a back flow of contaminated water from the city.

The plant consists of 20 wells 6 ins. diameter, 35 to 50 ft. deep, ranged in double rows 25 ft. apart and 1,000 ft. long. Each well has a full 4½-in. open-end suction tube, connected with a wrought iron main varying from 8 to 12 ins. in diameter. There are two compound, surface-condensing, duplex plunger pumps of Worthington make; one 3,000,000 and one 2,000,000 gallons daily capacity, and a suitable boiler plant. The water is pumped direct from the wells into a wrought iron stand-pipe, 25 ft. diameter and 140 ft. high, through a 20-in. interior tube, rising 5 ft. above the top of the stand-pipe. There are two lower openings, which afford opportunity for filling the stand-pipe at lesser head if required. The objects of this interior tube are threefold: 1, By its fountain action, to enforce complete aeration; 2, to cause complete circulation; 3, to afford instant fire pressure, no matter what the elevation of water in the main tower. For this latter purpose there is a by-pass not otherwise used, connecting the rising main and the distribution line. The city's supply is drawn regularly from the bottom of the stand-pipe.

The pipe system comprises some 30 miles of mains from 6 to 16 ins. diameter, with about eleven fire hydrants and six valves per mile. There is a "loop" or "double-feed" system dividing the city into districts, each practically complete in itself. The main to the east runs eleven miles to Elizabeth, supplying three other towns and several smaller places on its way. There are blow-offs at all low points and brook crossings. The hydrant pressure ranges from 40 to 75 lbs. per sq. in.

There are about five miles of macadamized and telford pavement streets. In other streets the pipe was laid 5 ft. from the curb, so as to avoid the stone pavement. The minimum cover is about 3 ft. No rock was encountered in trenching. The cost of laying includes everything except the cost of hydrants, and the cost per lineal foot of pipe laid is given as 63 cts. for 6-in., 89 cts. for 8-in., $1.34 for 12-in., $2.10 for 16-in. pipe.

After a partial completion of the work, additional tests were made with the permanent pumping plant. The wells on the westerly line were found to yield more abundantly than the easterly when under equally good conditions, and gave a lower vacuum for the same quantity pumped. This simply indicates that the underground water was flowing in a southwesterly direction. Tests were made with the large pumps, under both free discharge and full working heads, singly and together, and drawing from the wells in groups of 5, 10, 15 and 20; also by cutting off one by one until the smallest number that could be used was reached, and then adding one by one in a reverse order. The smallest number with which the pumps would run smoothly was five. The best results were obtained by using numbers 1 to 15 inclusive.

During the long-continued dry weather of 1891 the ground water level became so low that difficulty arose with the extreme suction lift obtained, which was from 20 to 28 ft., according to the rate of pumping. This was a fall in the ground water of 6 to 7 ft. since the earlier observations. For this reason in the summer of 1892 pumps were lowered 9 ft. below their former positions. The following test on wells No. 1 to No. 10, inclusive, shows the relation between speed of pump, suction lift and friction loss. This test occupied 24 hours, Aug. 12 and 13, 1891:

Capacity of pump	3,000,000 gallons in 24 hours
Full speed	124 strokes per minute
Delivery pressure	62½ lbs. per sq. in.
Average strokes per minute for 24 hours	58.4
Total amount pumped	1,460,010 gallons
Average suction lift, Well No. 1	21.78 ft.
Average suction lift, Well No. 9	22.83 "
Vacuum in engine room	26.16 ins.

A test for quantity with both pumps, continued for three full days, gave an average of about 3,000,000 gallons in 24 hours, with a suction lift of about 28 ft., the increase in lift being 1 ft. at the end of the third day. For the sake of convenience of observation and record, a 3-in. open tube was driven from the engine room into the water-bearing gravel, with a permanent float suspended in it, connected with a balanced pointer on a scale of feet placed in the room. When pumping, the average lowering of this gage is about 8 ins., with an almost immediate return after stopping.

A rainfall needs to be exceptionally heavy to materially affect the water level, and this does not occur in much less than 24 hours. This would seem to indicate that the water supply came from some distance. The wells have for two years furnished without dif-

* Abstract of a paper by Mr. Louis L. Tribus, read before the American Society of Civil Engineers, Feb. 21.

ficulty or any signs of decrease in the supply a full amount, beginning with 200,000 gallons, which has been increased to 1,500,000 gallons daily at the present time. The water has been of excellent quality, both for domestic and manufacturing purposes, and the underground supply has thus far proved a decided success.

INTERLOCKING PLANT FOR GRADE CROSSINGS OF ELECTRIC AND STEAM RAILWAYS.

With the rapid increase of electric railways the increasing number of grade crossings of electric railways with steam railways is being made evident by frequent fatal collisions, and still more frequent narrow escapes. The need of efficient protection for such crossings similar to that which is

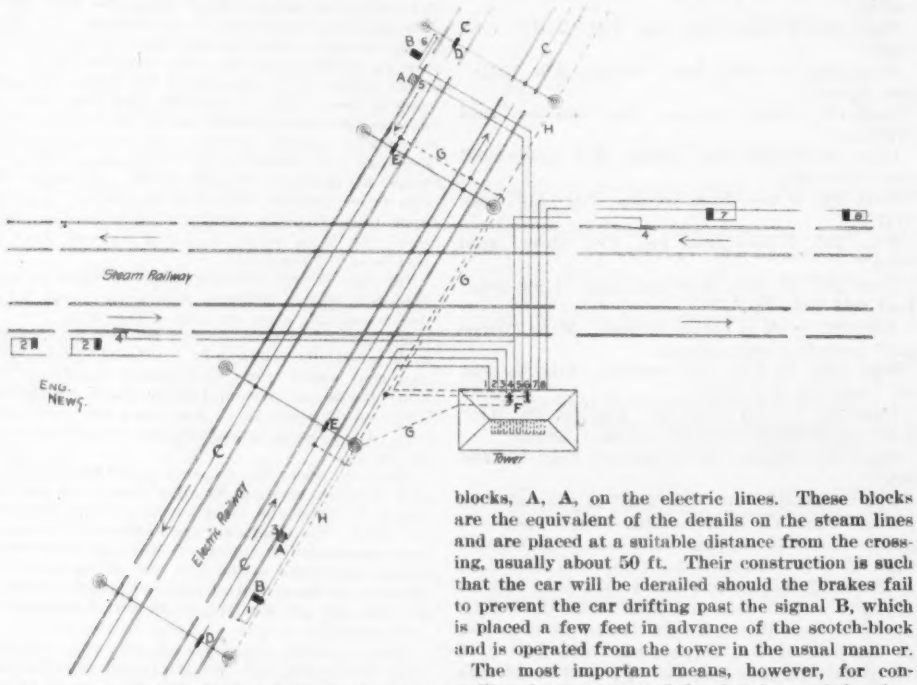


FIG. 1. PLAN OF INTERLOCKED CROSSING OF A STEAM RAILWAY AND AN ELECTRIC RAILWAY.

now provided in the best practice at the grade crossings of steam railways is coming to be generally realized, for the ordinary highway crossing gates do not afford sufficient protection. In our issue of Dec. 14, 1893, we briefly described an arrangement adopted at two crossings of the Chicago & North Shore Electric Ry. with the Evanston Division of the Chicago, Milwaukee & St. Paul Ry., at Calvary and Sheridan Park, Ill.; the apparatus for which was invented and patented by Mr. George Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry. We are indebted to Mr. Gibbs for particulars from which the following description has been prepared. The part of the interlocking which applies to the steam railway was put in by the Union Switch & Signal Co., but the remainder of the plant was built by the Chicago, Milwaukee & St. Paul Ry. Co.

The reasons for increased danger at crossings of steam railways by electric street roads over grade crossings by horse lines lie in the greatly increased speed of the electric cars, their great weight and inertia and the liability of failure of their source of power by the blowing out of a fuse or the jumping off of the trolley wheel when the car is jolting over rough crossing frogs, etc. Moreover, a recent and important development of electric traction is the suburban road, which competes with its steam rival in speed. The necessity for applying the same regulations for grade crossings of such railways as are now required by state laws in cases of steam roads becomes apparent. The apparatus designed by Mr. Gibbs is modeled on the ordinary mechanical interlocking machine for grade crossings, but has two important modifications as follows: 1, The motive power of the electric cars is cut off when it is necessary to block the line, and thus it is made absolutely impossible for the car to be moved in disobedience of the signals; 2, a derailing device is provided to prevent cars drifting over the crossing. A derail which could be successfully operated in paved streets must be of such a nature that it offers no obstruction to wagon traffic and must be free from liability to clog up with mud, snow or ice. The ordinary form of derail employed for steam roads obviously does not fulfill these conditions.

The general plan, Fig. 1, shows a double track crossing of a steam and electric railway. The tower is placed in any convenient location and contains the interlocking machine. The pipe line and wire lead-outs for operating the signals and derailing switches on the steam tracks require no explanation. Similar lead-outs are run to the scotch-blocks, A, A, on the electric lines. These blocks are the equivalent of the derails on the steam lines and are placed at a suitable distance from the crossing, usually about 50 ft. Their construction is such that the car will be derailed should the brakes fail to prevent the car drifting past the signal B, which is placed a few feet in advance of the scotch-block and is operated from the tower in the usual manner.

The most important means, however, for controlling the movement of the electric cars is by placing the supply of current under control of the towerman, through the interlocking machine. At a suitable distance (500 to 1,000 ft., according to circumstances) before reaching the crossing, the trolley

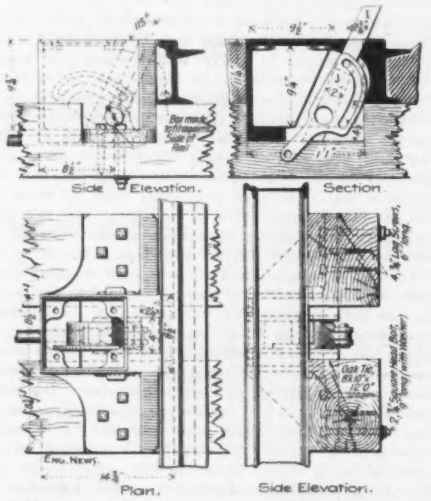


Fig. 2. Scotch-Block Used on Electric Tracks of Interlocked Crossing

wires C, C are broken by the insertion of a circuit breaker, or insulating block D, and at a point about 30 ft. from the crossing, another circuit breaker E is inserted. A feed wire for this insulated section D E is run to the electric switch F in the tower. This switch is connected to the lever of the interlocking machine, and is supplied with current by means of the wire G which taps the main line feeder H. Thus, by opening or closing the switch, current may be cut off from or supplied to the insulated trolley wire section at will. It will be noticed that the insulated section is terminated a few feet from the crossing; this is an important provision, as it insures a "live" section over the crossing at all times, making it impossible for a careless towerman to cut the motive power from a car which may happen to be on the crossing when a clear signal is given for the steam road. The devices on both roads are, of course, interlocked in the usual manner, so that before a clear signal can be given for the steam road the current cust be cut off on the electric line approaches, the signals set at danger and the scotch-blocks raised to derail.

The details of the scotch-block are shown in Fig. 2. It consists of a strong cast iron box, which is set outside of the rail and bolted securely to the ties, so that its top is flush with the street paving. In the top of the box and against the rail is an opening 2×4 ins., in which is set a wrought iron plug I to form the stop block. This plug is raised and lowered by means of the slotted crank J connected by pipe line to tower. It will be noticed that the line of motion of this plug is oblique to the axis of the rail, and the crank having a throw of 4 ins., the plug in its derailing position projects this distance from the box and over the rail head, making an efficient device for throwing the car from the track. It will be noticed also that the slotted crank has a shoulder, and in its upper position the square end of the plug rests upon this shoulder in line with the axis of the arm and crankpin. The plug is therefore locked in its extreme position and the downward thrust of a car wheel is taken upon the strong pivot pin without bringing the strain upon the pipe line connection. The construction of the block is such that it is self-clearing of dirt, ice, etc., and the moving parts are effectually protected from such obstructions, drainage being provided through the open bottom of the box.

Warning of the approach of an electric car is given to the towerman by a novel and simple annunciator consisting of a local battery bell circuit, actuated by a relay placed in the loop of the trolley wire, which is brought into the tower. As soon as a car using current passes into the insulated trolley wire section, the magnet of the relay is energized and closes the bell circuit, giving the alarm.

The apparatus is in no sense experimental, consisting only of well known interlocking devices, with the addition of simple means for more complete protection afforded by control of the motive power of the electric road. The cost of the apparatus is considerably less than that of interlocking plant for a plain crossing between two steam roads, for the reason that fewer levers are required and the same pipe line is used to actuate both the stop block and signal, and these being set within 50 ft. of the steam railway, the lead-out is inexpensive. The same may be said of the means for controlling the motive power, which consists of short lengths of tap wires to the trolley wire and the jack-knife switch in the tower, connected to the lever of the interlocking frame by a link.

COST OF NEW YORK CENTRAL R. R. TRACK THROUGH PAVED STREET.

The improved arrangement designed by Mr. Walter Katte, Chief Engineer of the New York Central R. R., for laying the standard railway track through paved streets was illustrated and described in our issue of Jan. 25, and consists essentially of supporting the track rails on iron chairs and bolting a continuous angle iron or tram rail to the inside of each track rail, forming in effect a side bearing street rail. Since publishing that description we have received from Mr. Katte the following figures of the cost of one mile of single track. The unit prices are the exact cost of the work laid in Syracuse, N. Y., last year; but with the reductions which have since taken place in the market prices of iron and steel the cost now would be fully $950 (or 7%) per mile less:

One Mile of Single Track.	
125 5-7 tons of 80-lb. steel rails, at $29.60	$3,721.24
Drilling extra bolt holes in rails	344.96
47 tons of 30-lb. tram rails, at $50.90	2,392.30
11,000 lbs. of splice bars, at 2 cts. per lb.	220.00
4,576 bolts and nuts, at 3.2 cts. each	146.43
8,450 lbs. of track spikes, at 2¼ cts. per lb.	197.17
5,632 cast iron chairs and malleable clips, at 50 cts. each	2,816.00
2,816 yellow pine cross ties, at 55 cts. each	1,548.80
1 mile of labor at tracklaying, lining and surfacing and ballasting, at 40 cts. per lin ft.	2,112.00
Total	$13,498.00

Summary.

5,280 lin. ft. materials, at $2.157	$11,388.00
5,280 lin. ft. labor, at $0.40	2,112.00
Total	$13,500.00

One Switch and Frog Complete.

1 Duggan switch, including chairs, lever and cast iron box for same, complete	$150.00
1 No. 10 frog, 80-lb. steel rail, with chairs	63.00
Track rails between switch and frog	45.00
Labor, laying	62.00
Total	$320.00

THE VERTICAL INFLUENCE OF THE COUNTERBALANCE.

At the meeting of the New York Railroad Club on Feb. 15, a paper with the above title was read by Mr. R. A. Parke, M. E. The paper was a mathematical discussion of the theory of locomotive counterbalancing, and the author developed certain formulas for practical use by locomotive designers. The paper was much too long for reproduction in these columns and we therefore give only the author's general discussion and the results obtained, omitting the detailed mathematical solution. Any of our readers desiring to investigate further the methods pursued by the author may obtain a copy of the complete paper by addressing the secretary of the Club, Mr. John W. Hill, Temple Court, New York city:

There are four necessary and distinct considerations in determining the counterbalance of locomotive driving wheels:

(1). The wheel itself, including the crank and crank-pin, must be balanced by a certain weight of counterpoise.

(2). The weight of the parallel rod or rods which the crank-pin carries requires a certain additional weight in the counterpoise.

The sum of these two weights of counterpoise causes the wheel and parallel rod to be balanced for all positions of the wheel and for any speed whatever.

(3). The counterpoise of the main driving wheel should have a certain additional weight, to balance the influence of the main rod and reciprocating parts, when the crank-pin is vertically above or below the center of the wheel.

(4). A certain additional weight should be distributed among the counterpoises of the different driving wheels, to more nearly secure horizontal balancing of the main rod and reciprocating parts.

The matter will be considered in the order of these subdivisions.

The most difficult features of the practical application of the mechanical laws involved in counterbalancing are, without any doubt, to be found in the proper balancing of the wheel itself.

By reference to Fig. 1 it will be at once seen that the wheel is symmetrical about the center O, except in certain portions, and that if the sectors lying between the hub and the outer boundary of the counterpoise, and included within the angles a O b and i O o, be removed, the wheel will be perfectly balanced in any position. To balance the wheel as a whole, therefore, it is necessary that the weight of the counterpoise, together with that of the remaining portion of the spokes e and f, shall balance the weight of the crank and crank-pin and that of the portions of the spokes and rim included within the dotted sector corresponding to the counterpoise. In order to determine the weight of the counterpoise, necessary to produce a balance of the wheel, it is necessary to calculate (a) the weight of that portion of the crank extending beyond the hub of the wheel, together with the projecting crank-pin, and the distance of the center of gravity of the combined mass from the center O; (b) the sum of the weights of the portions of the four spokes shown within the dotted sector, corresponding to the counterpoise, and the distance of the center of gravity of the combined four from the center O; (c) the weight of the sections of the rim included in the dotted sector, and the distance of its center of gravity from the center O; (d) the weights of the portions of the spokes e and f, between the counterpoise and the hub, and the distance of the center of gravity of their combined mass from the center O, and (e) the distance of the center of gravity of the counterpoise from the center O.

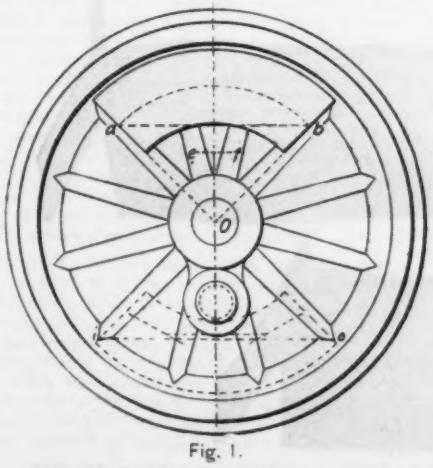


Fig. 1.

The author then proceeds to explain the method of computing the position of the center of gravity of these various parts, the distance out to which he takes as the lever arm of each of the various parts in computing the centrifugal force of each. It will be noted that this is not strictly correct, as the radius of gyration should be used in computing the centrifugal force of each part instead of the distance out to its center of gravity. Thus the author's statement above that "the sum of these two weights of counterpoise causes the wheel and parallel rod to be balanced for all positions of the wheel and for any speed whatever" is not strictly correct. Multiplying the weight of each part by the distance out to its center of gravity gives a standing balance only; but the radius of gyration must be used if a running balance is to be secured. At the same time it is fair to say that for weights of the form commonly used as counterweights, the error introduced by using the distance to the center of gravity is probably not great enough to be of practical importance.

So much for the wheel itself. The author next determines the additional weight of counterpoise required to balance the weight of parallel rod which the wheel carries. Of course, if the ends of the parallel rod are alike and its body is symmetrical, each wheel to which it is connected will carry one-half its weight. Otherwise the position of the center of gravity of the rod is determined by balancing it on a straight edge, and the proportion of weight carried by each wheel is computed. Then the additional weight of counterpoise, W‴, needed to balance the weight of parallel rod which the wheel carries, P, equals

$$\frac{Pr}{c}$$

where r = the distance between the centers of wheel and crank-pin, and c = the distance from the center of the wheel to the center of gravity of the counterpoise.

Thus far, the problem has been simply one of mechanical leverages and weights. The effect of the weight and motion of the main connecting rod and reciprocating parts upon the main driver is a much more complicated matter. The method used in determining it was suggested to the writer, some years since, by Prof. I. P. Church, of Cornell University.

In Fig 2, O is the center of the driver, C is the center of the wrist-pin, r = radius of crank circle in feet and l = length of main connecting rod in feet. The end of the rod C has a reciprocating horizontal motion, while the other end moves in a circle with the crank-pin. The

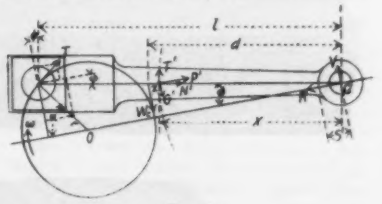


Fig. 2.

motion of the rod may, therefore, be separated into two component motions—one, a motion of horizontal translation, and the other an oscillating or pendulum-like motion about the center C. The crank-pin revolves with a uniform angular velocity, ω. The crank-pin exerts a pressure or force upon the rod, in some direction, at each instant. This variable force may be resolved into two components; one, N, normal to the crank circle and pointing toward or away from the center O; the other, T, tangential to the crank circle or at a right angle with the normal. The reciprocating parts (piston, piston rod, cross-head and cross-head pin) exert a force, R, upon the end of the rod at C, in a horizontal direction, and the guides react upon the same end of the rod with a vertical force, V. The weight of the rod We, is also a force acting downward through the center of gravity of the rod. At any instant the crank will stand at some angle, α, with the horizontal center line O C, and the connecting rod will be at some angle, φ, with the line O C. The direction of each of the forces, N, T, R, V and W_c is known, though the amount of each except W_c, or whether it is positive or negative, is unknown.

By applying these forces to the rod, if the friction of the pins be neglected, the rod may be considered a free body, and through the action of these forces the rod will move in exactly the same way as actually occurs.

At any instant, a particle, z, at any point in the rod, may be regarded as being acted upon by four forces, as follows: A horizontal force, P′, to cause its motion of translation; a tangential force, T′, giving the particle its oscillatory movement; a normal or centripetal force, N′, restraining the particle from deviating from its oscillatory path; and the force G′, of gravity, acting vertically downward. At the same instant, each other particle in the rod may be considered to be acting under similar forces. Each of these imaginary forces may be resolved into horizontal and vertical components. The sum of the vertical components of all these imaginary forces must, at any instant, be equal to the sum of the vertical components of all the applied forces. Similarly, the sum of the horizontal components of the imaginary forces equals the sum of the horizontal components of the applied forces. Also, the sum of the moments of the imaginary forces, about the center C, equals the sum of the moments of the applied forces, about the same center.

Without reproducing the series of equations which follow, covering several pages of the paper, we give the result reached in the final equation, which is:

$$W''' e = W_c r \frac{r^2 + k^2 - r d \left(1 - \frac{r}{l}\right)}{l^2 - r^2} + W_p r \frac{r^2}{l^2 - r^2} \quad (5)$$

In which W‴ = the weight of counterbalance necessary to balance the vertical effect of the main rod, e is as before the distance out to the center of gravity of the counterbalance, W_p = the weight of the piston, piston rod and crosshead, d = the distance of the center of gravity of the rod from the center of the crank-pin, and k = the radius of gyration of the rod from this center. The other quantities in the equation are given in the quotation above. It is understood, of course, that this extra counterbalance, to balance the vertical effect of the main rod and its connected parts upon the main driver, should be added to that driver, and is plus the counterbalance required on that driver to balance the weight of the crank and the weight of the parallel rod which it carries. On other drivers than the main driver only the weights forming part of the wheel itself and the weight of parallel rod carried need to be considered for perfect vertical balance.

Horizontal Balance.

The author next takes up his requirement (4) that the inertia of the reciprocating parts shall be balanced. From a general equation introduced in the discussion of the vertical effect of the reciprocating parts he obtains equations for the normal force of the reciprocating parts when the engine is on the forward center and when it is on the rear center, and finds that:

These horizontal values of the normal force are not equal, and it is at once apparent that if a counterpoise be used which will balance the main rod and reciprocating parts at one end of the stroke, these parts will not be balanced at the other end of the stroke. There are two reasons for this, both of which are perfectly evident. One is that, on account of the angularity of the main rod, the velocity of the reciprocating parts, both in the completion of the stroke and in the beginning of the return stroke, is greater at the forward than at the rear. The parts have to be stopped from a higher velocity and started back at a higher velocity at the end of their forward movement than at the end of the backward movement. The other reason is that the oscillating motion of the main rod produces a centrifugal force, which is always, in direction, toward the rear of the locomotive and which is greatest when the engine is on center. Fortunately, this latter condition partially offsets the uneven action of the reciprocating parts, just previously pointed out. It is certain, however, that a locomotive cannot be horizontally balanced for any speed whatever. The nearest approach to horizontal balancing will be attained by balancing for the mean of the two horizontal values of the normal force above found.

But a certain portion of this normal force has already been provided for by a weight, W‴, in the counterpoise of the main driver, which balances the vertical plane of the normal force.

For the most nearly perfect horizontal balancing, therefore, a counterpoise must still be provided for the difference between the mean horizontal value of

the force N, and this vertical value of N. Let this difference = Q; then

$$Q = M_1 \omega^2 r \frac{l^2 - 2r^2 - k^2 + r\,d\left(1 + \frac{r}{l}\right)}{l^2 - r^2} + M_2 \omega^2 r \frac{l^2 - 2l^2}{l^2 - r^2} \quad (6)$$

in which M_1 = the mass of the connecting rod, M_2 = the mass of the piston, piston rod and crosshead, and ω = the angular velocity of the crank. The other quantities have been already given.

A statement has been recently published to the effect that the best results are obtained when the locomotive is fully balanced horizontally. It will be quite clear that, if a further weight of counterpoise be now added to balance the force Q, the locomotive will be overbalanced vertically. This step will doubtless call forth one kind of criticism from the men in charge of the locomotive and another kind from the men who have charge of the bridges and of track repairs. It is well known that some persons favor full balancing for the horizontal force Q, while others favor balancing for only a portion of such horizontal force. Let it be assumed therefore that a certain percentage, m, of the force Q will be balanced. Let W_ε = the weight of counterpoise necessary to balance such a percentage of Q. Then

$$W_\varepsilon c = m\,W_c r \frac{l^2 - 2r^2 - k^2 + r\,d\left(1 + \frac{r}{l}\right)}{l^2 - r^2} + m\,W_p r \frac{l^2 - 2r^2}{l^2 - r^2} \quad (7)$$

It remains to be determined how the weight W_ε shall be distributed among the various drivers. It could, of course, be all placed in the counterpoise of the main driver, or of any other driver, and would produce the proper effect in horizontal balancing. But such a course would result in a most serious disturbance of the vertical balance of that driver. The rational manner of distributing the weight W_ε, so as to cause the least vertical disturbance, is to so divide it among the counterpoises of all the drivers that all will be equally out of balance vertically. In other words, $W_\varepsilon c$, of equation (7), should be divided by the number of pairs of drivers, and the weight of counterpoise added to each wheel for horizontal balancing would be determined as follows:

$$W_{\varepsilon_1} c_1 = W_{\varepsilon_2} c_2 = W_{\varepsilon_3} c_3 = \text{etc.} =$$

$$m\,r \left\{ \frac{W_c \frac{l^2 - 2r^2 - k^2 + r\,d\left(1 + \frac{r}{l}\right)}{l^2 - r^2} + W_p \frac{l^2 - 2r^2}{l^2 - r^2}}{\text{No. of pairs of drivers.}} \right\} \quad (8)$$

It will always facilitate computation, if the distance of the center of gravity from the center of the wheel is the same for all the drivers of the locomotive, so that $c_1 = c_2 = c_3$, etc. It is suggested that this can be accomplished by using the same shape of counterpoise (for instance, as shown in Fig. 1) for each of the drivers and varying the weights, W_1, W_2, W_3, etc., by different thicknesses. It is, of course, desirable to have the center of gravity of the counterpoise as far as possible from the center of the wheel, so as to reduce the weight as much as possible. The counterpoise should therefore be compact and as near the tire of the wheel as is practicable. Instead of extending the angle occupied by it to secure greater weight, and, by so doing, bringing the center of gravity nearer the center of the wheel, it is often made hollow and filled with lead to increase the weight.

In equations (5) and (8) for finding the weights W'''' and W_ε, for vertical and horizontal balancing of the reciprocating parts, the radius of gyration, k, and the distance of center of gravity, d, of the main rod from the center of the wrist-pin, may be expressed in terms of l, and, in turn, l may be expressed in terms of r, and those equations simplified. There are simple methods of experimentally finding the radius of gyration, although its mathematical calculation, in the case of the connecting rod, is somewhat complex. In the case of the ordinary form of locomotive connecting rod no material error will arise from giving to k^2 the value $\frac{1}{6} l^2$. It will also be found that d, the distance of the center of gravity from the center of the wrist-pin, will not be far from $\frac{5}{8} l$. Substituting these values of k^2 and d in equations (5) and (8), equation (5) becomes

$$W'''' c = W_c r \frac{\frac{5}{8} r^2 + \frac{1}{6} l^2 - \frac{5}{8} r\,l}{l^2 - r^2} + W_p r \frac{r^2}{l^2 - r^2} \quad (9)$$

and equation (8) becomes,

$$W_{\varepsilon_1} c_1 = W_{\varepsilon_2} c_2 = \text{etc.} =$$

$$m\,r \left\{ \frac{W_c \left(\frac{1}{6} l^2 - \frac{1}{8} r^2 + \frac{5}{8} r\,l\right) + W_p (l^2 - 2r^2)}{(l^2 - r^2) \times \text{No. of pairs of drivers}} \right\} \quad (10)$$

These equations are very simple of application and are entirely practicable.

The author then proceeds to discuss the vertical disturbance produced by balancing when the conditions laid down in the above discussion are not complied with. A mogul locomotive with badly balanced wheels was taken as an example and computations showed that the main driver was not counterbalanced enough for vertical balancing alone. The counterbalance weights in the front and rear drivers were sufficient to balance 30.6% of the horizontal effect. Had all the drivers been properly balanced, each would have had at a speed of 70 miles per hour, an unbalanced vertical force of 4,239 lbs. The author continues:

As the weights were actually distributed, when the counterpoises are upward, there is a decrease of pressure upon the rail by the rear driver of 7,742 lbs., an increase of pressure of 5,315 lbs. by the middle driver, and a decrease of pressure of 10,323 lbs. by the forward driver. With half a revolution of the drivers the conditions are reversed, so that, in exactly one-tenth second, the pressure of the forward driver upon the rail varies over 10 tons, while that of the rear driver varies nearly 8 tons. The tendency of these heavy strains to produce a rapid vibratory flexure of the locomotive frame would hardly seem to be an insignificant element in the cost of repairs; in any event, it would be difficult to show that such conditions are not injurious to the track.

It is not difficult to conjecture how the counterpoise weights came to be distributed in such a manner by the designer. For the main driver, $W_2 c_2 = 1,0^{\circ}5$. If the counterpoise for that driver had been made solid to the wheel hub for a complete semi-circle, and 7 ins. thick, $W_2 c_2 = 1,250$ only. As much weight as appeared desirable seems to have been given to the counterpoise of the main driver, and the balance of the weight was divided between the other drivers in the most "calculation-saving" manner.

The smaller the drivers, generally speaking, the greater is the weight of the reciprocating parts, while the opportunity to properly dispose of the necessary weight of counterpoise is much reduced. Unless the reciprocating parts of locomotives are reduced in weight considerably below that of present practice, the cost of maintenance of locomotives for high speeds will inevitably be great.

There are locomotives all over the country balanced not only as badly as, but worse than, the one just considered. The writer has seen many eight-wheel passenger engines in which the counterbalance weights are the same upon the forward and rear drivers. There are no possible conditions under which a locomotive so balanced could be considered well designed.

In the remaining portion of the paper the author gives a mathematical solution of the problem: Given a locomotive so counterbalanced as to give a certain unbalanced vertical force, at what speed will the drivers begin to rise from the rail when the counterbalances are up, and what will be the height of the rise and the arc during which they will off the track? The following is the conclusion:

From the figures obtained it is clearly indicated that, for locomotives of even the highest speed, there is no likelihood of a driver leaving the rail, if any reasonable consideration is given to the matter of counterbalancing.

In conclusion, it should be pointed out that there is exclusively one method of locomotive design which will render both the horizontal and vertical disturbances a minimum. This is to reduce the weight of the reciprocating parts to a minimum. The use of compound locomotives for high speeds, with the excessive weight of reciprocating parts customarily employed, must be accompanied by very serious wear and tear upon the roadway. It is very difficult to estimate such damage; but it is believed by the writer that, if the actual cost to railroads of repairs and renewals, of all kinds, arising from this one source of damage, could be ascertained, it would be found that the use of steel for pistons and cross-heads would be abundantly justified for all high-speed locomotives; and that, very possibly, the expense due to the use of hollow steel piston rods and of aluminum pistons and cross-heads would also be justifiable for high-speed compound locomotives.

RECENT EXPERIENCE WITH TIEPLATES.

By Benjamin Reece, M. Am. Soc. C. E.

Fig. 1 of the accompanying illustrations shows an oak tie which was in service ten years on a 78-ft. grade, on the Pittsburg, Cincinnati, Chicago & St. Louis Ry. bridge (J. M. & I. R. R.), over the Ohio River, at Louisville, Ky. This tie for six years had no protection and, with others, was marked for removal because of cutting in of rail flanges. The ties being sound, it was concluded to try the Servis tieplates and the ties were suffered to remain. During the four years' use of the plates no work has been done upon the track, whereas, prior to that time, three carpenters were almost constantly engaged in shimming, lining and correcting the gage. In the spring of 1893 a number of ties were found to be rotting away, but the plates were still affording ample support to the rail. Such ties were removed, with the exception of the one photographed, which was suffered to remain as an experiment. This tie was removed in November, 1893, in the condition shown, and to the day of its removal it carried 150 trains per day without any movement of the plate. The illustration shows very clearly the compacting and compressing of the wood fiber between the longitudinal flanges, excluding moisture, making the plate integral with the tie, and clearly shows why this form of plate cannot rattle, and why the labor of repairs is so much reduced. The black ridge on left hand end of plate is the oil and dirt accumulation caked to the plate. A similar ridge on the opposite end was scraped clean by the rail flange when the tie was drawn out from under the rail.

FIG. 1. TIE WITH SERVIS TIE PLATE; LOUISVILLE BRIDGE.

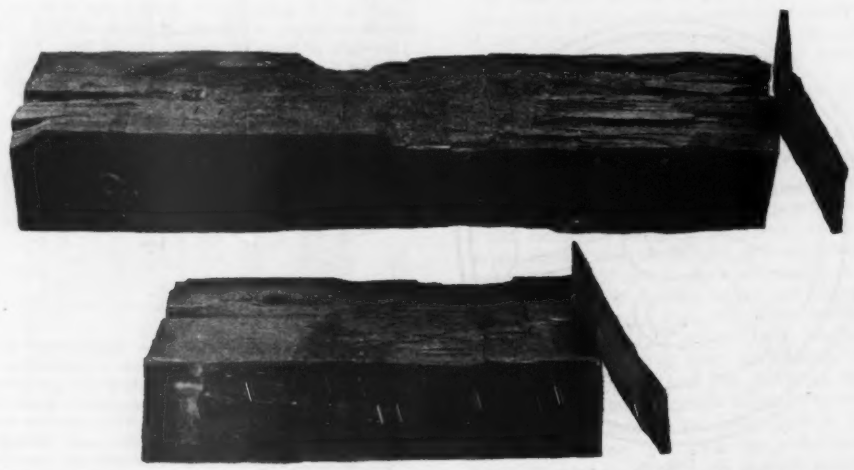


FIG. 2. TIES SHOWING EFFECTS OF FLAT TIE PLATES; MANHATTAN ELEVATED RAILWAY.

Fig. 2 shows two specimen yellow pine ties selected from a large number removed from the Manhattan Elevated Ry. tracks, in New York city, in January, 1894. These ties had been less than six years in the track and had to be removed because of decay due to the effects of moisture under the flat bottom tieplates used to protect the ties from the cutting action of the rail flanges. The photograph shows two ties which were selected to show the extremes of condition observed. In the upper tie the rot extended to the sapwood beyond the plates, as shown. The lower of the two ties had remained in the track five years and three months when it was removed. Being a heart tie the rot was confined to the portion of the tie covered by the tieplates, the remainder of the tie being still sound. The reader can imagine other ties removed showing varying stages of decay between the extremes indicated by the ties above shown.

To protect the ties of this line against the cutting action of the rail some flat tieplates $6 \times 8\frac{1}{4}$ ins. were applied in 1888. These plates in addition to buckling and cracking at the ends, as shown in the cut, induced premature decay of the portion of the ties which they covered. As these plates had no union with the ties, they jumped and rattled under the rail. The suction produced by the jumping plates drew the moisture into the depression which the moving plates had worn into them, the jumping plate thus literally pumping water into the ties. In less than six years the ties were removed because of this rotting away under the tieplates, the very part of the tie where soundness is most required to securely hold the fastenings, and give support to the rail.

As might be expected forms of plates which cut across and sever the fibers of the ties aggravate the tendency to rot under the plates. This led to the practical abandonment by European engineers of nearly all forms other than the flat bottom plates.* The difficulties attending their early application are by them overcome in part by fastening them securely to the ties; for this purpose lag screws, bolts and wood pins, sometimes bored through the center and reinforced with iron dowels, are used. Of course, as the fibers of the wood compress under the plates, such fastenings loosen and it is required to tighten them at more or less frequent intervals.

The contract for Sec. 1 of the Chicago Drainage Canal is to be relet, and bids for it, together with 3,000 ft. of river levee and 700 ft. of main channel, will be received until April 18, as stated in our advertising columns. The original contractor for this work was Mr. Alfred Harley.

An 800-ton hopper dredge, for excavating a channel through rock at Bermuda, has been built by Lobnitz & Co., of Renfrew, Scotland. This dredge is 208 ft. long, 40 ft. wide, 17¼ ft. deep, and has a loaded displacement of 2,200 tons. The vessel is built of steel throughout and has a speed of 7 knots, being propelled by twin screws driven by independent triple-expansion engines of 800 HP. The dredging gear, ladder and bucket chains are claimed to be the strongest ever made. They are made of steel and weigh, together, about 100 tons. This vessel will dredge to a depth of 45 ft. below the surface, and she can either deliver the spoil into barges alongside, or into the two steel hoppers on board, which together have a capacity of 7,000 cu. ft. Special rock-cutters are provided for breaking rock exceptionally hard.

The so-called "Banana Special" of the Gulf, Colorado & Santa Fe R. R., lately made the 1,385 mile run from Galveston, Tex., to Chicago, in 53 hours. This is an average of 26.13 miles per hour. The actual running time was 50.57 hours, or at the rate of 27.54 miles per hour. This is an excellent long-run record for a freight train, and shows that Galveston is making strenuous efforts to compete with Mobile and New Orleans for the distribution of Gulf trade in territory generally assumed to belong only to the two nearer ports.

The latest electric carriage for use on highways is the invention of Paul Pouchain, of France. It is a phaeton on four wheels, with seats for six passengers, and outwardly looks very much like an ordinary carriage. The electric current is furnished by a Dujardin storage battery, of 54 cells, contained in six boxes, each box being 17 × 14 ins. and 13.6 ins. high. The Rechminsky motor used has a normal energy of 2,000 watts (2.68 E. HP.), and operates a shaft connected by chains to sprocket-wheels on the rear axle. The vehicle, in working order, weighs 2,970 lbs. On a pavement in average condition 42½ miles can be covered at one charging, at a speed of 9 miles per hour. The carriage can be turned around in a street 13 ft. wide. The cost of operation is not given.

(* In Europe heavier plates are still in general use. The Post tieplate, used extensively in Holland and Belgium, has sharp teeth on the underside to bite into the wood, and so prevent slipping.—Ed.)

PERSONALS.

Mr. C. W. Gay has been elected City Engineer of Lynn, Mass.

Mr. George Bowers has been re-elected City Engineer of Lowell, Mass.

Mr. T. McNabb has resigned his position as Superintendent of Bridges and Buildings of the St. Louis Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. A. H. King has been appointed Superintendent of Bridges and Buildings of the Wyoming Division of the Union Pacific R. R., with headquarters at Cheyenne, Wyo.

Professor Barnard, of Lick University, California, has accepted an appointment as astronomer at the University of Chicago, where the great Yerkes telescope is to be erected.

Mr. Arthur R. Sweet has been elected City Engineer of Woonsocket, R. I. He has been Superintendent of Sewers of that city and was formerly City Engineer of Pawtucket, R. I.

Mr. W. K. Morley, formerly Division Superintendent of the Chicago & Alton R. R., has been appointed General Superintendent of the Kansas City, Pittsburg & Gulf R. R., with headquarters at Kansas City.

Mr. L. H. Clarke has been elected President of the Truss Rail Joint Co., of Chicago. He was formerly Chief Engineer of the Lake Shore & Michigan Southern R. R., and later City Engineer of Chicago.

Mr. Frank E. Snyder has been appointed a member of the engineering department of the Railroad Commission of Texas, with headquarters at Austin, Tex. He was Assistant City Engineer of Dallas, Tex., for several years.

Mr. Clifford Richardson, of Washington, D. C., will, on March 1, sever his connection with the Engineer Department of the District of Columbia and open an office as consulting expert in technical chemistry, with special reference to asphalt, hydraulic cement, water and the general inspection of construction material.

Gen. Jacob Ammen, U. S. A., died at Lockland, O., Feb. 6, at the age of 88. He graduated from West Point in 1831 and served at that academy as acting assistant professor of mathematics and assistant professor of natural and experimental philosophy until Nov. 30, 1837, when he resigned to accept the position of professor of civil engineering in Bacon College, Georgetown, Ky. He served with distinction through the Civil War. Since the war his only public service was a term of two years as engineer of Hamilton Co., O., and a tour of observation on the Isthmus of Panama and in Central America in 1872, where he was sent by the U. S. Government with a party of distinguished army and naval engineers to report upon the probable fate of the De Lesseps scheme and the feasibility of the Nicaragua Canal.

NEW PUBLICATIONS.

SELECTED PAPERS OF THE RENSSELAER SOCIETY OF ENGINEERS, Troy, N. Y.—Edited by the Committee on Publication. January, 1894. 50 cts.

This publication was commenced some years ago, but owing to some unavoidable difficulties it has not been issued for the past two years. The committee now propose to issue it regularly again, and present four very good papers in this number, three of which are in the form of student notes, covering subjects from which they are expected to recite.

EXECUTIVE HEALTH OFFICERS OF ONTARIO.—Report of the Eighth Annual Meeting of the Association at Guelph, June 27 and 28, 1893. Also List of Officers and Contents of Annual Proceedings from 1877 to 1893. F. H. Bryce, M. D., Toronto, Secretary. Paper; 8vo; pp. 175.

Among the other papers this report contains one on the "Toronto Water Supply," by J. J. Cassidy, chairman Provincial Board of Health, Toronto, and another on "Systems of Sewerage Available for Ontario Towns and Villages," by Mr. Allen Macdougall, of Toronto. The former paper is principally an argument in favor of purchasing water by the thousand gallons from a company that desires to supply Toronto from driven wells. The latter discusses the difficulties involved in securing money for the smaller towns of Ontario, owing to costly rock excavation, and advocates the placing of small lateral sewers at the rear of houses, some 2 to 3 ft. below the ground surface. The laterals carrying only house sewage of high temperature would be in little or no danger of freezing. Often the small amount of sewage to be handled could be readily purified by intermittent filtration, or the ferrozone and polorite systems might be adopted.

TRADE PUBLICATIONS.

HISTORY OF A LEAD PENCIL.—By Walter Day. Jos. Dixon Crucible Co., Jersey City, N. J. 12mo; pp. 16; illustrated.

This little pamphlet describes the manufacture of pencils of different varieties.

BELTING.—Page Belting Co., Concord, N. H. 8vo; pp. 36; illustrated.

This pamphlet contains a history of the company, a description of its exhibit at the Columbian Exposition, and several views of machinery run by this belting at the Exposition.

TESTING MACHINES.—Tinius Olsen & Co., Philadelphia, Pa.; 4to; pp. 42; illustrated.

This is an illustrated catalogue of testing machines of various sizes and types, including impact testing machines and a machine for testing structural material up to 400,000 lbs. Micrometers and other appliances are also illustrated.

SOCIETY PROCEEDINGS.

ENGINEERING ASSOCIATION OF THE SOUTH.—At the meeting on Feb. 8 a paper was presented by Mr. Tyler Calhoun, Superintendent of the Whitwell Colliery of the Tennessee Coal, Iron & Railway Co., describing in detail the method of handling coal at these mines by gravity. An abstract is given in another column of this issue.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—At the meeting on Feb. 14 the discussion of stationary engine design, as illustrated by the World's Fair exhibits, was continued. An abstract is given in another column. At the meeting on March 14 the subject will be "Testing Machines and Tests of Materials," to be opened by Mr. J. Sellers Bancroft, of Philadelphia.

COMING TECHNICAL MEETINGS.

DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 27. Secy., F. E. King, Jacobson Block.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Feb. 28. Secy., J. A. Pilcher, Roanoke, Va.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
March 3. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
March 3. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 106 Randolph St., Chicago. Secy., C. T. Anderson.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
March 5. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
March 6 Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
March 7. Secy., J. W. Weston, Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
March 7. Secy., Wm. H. Bryan, Turner Bldg.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
March 7. Secy., F. Collingwood, 127 E. 23d St., New York
CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 8. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERING ASSOCIATION OF THE SOUTH.
March 8. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS' AND ARCH'TS CLUB OF LOUISVILLE.
March 8. Secy., F. W. Mowbray, Norton Building.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
March 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
March 12. Secy., M. F. Schinke, City Hall, Milwaukee.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
March 13 Secy, F. C. Osborn, Case Library Building.
NORTHWEST RAILROAD CLUB.
March 13. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
March 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
March 14. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
March 14. Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
March 14. Secy., F. R. Hutton, 12 W. 31st St., New York.
ENGINEERS' CLUB OF CINCINNATI.
March 15. J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
March 15. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOC. OF CHICAGO.
March 15. Secy., Howard Berge, 100 Washington St.
TACOMA SOC. OF ENGINEERS AND ARCHITECTS.
March 16. 201 Washington Building.
NORTHWESTERN TRACK AND BRIDGE ASSO'N.
March 16. Secy., D. W. Meeker, St. Paul.
ENGINEERS' CLUB OF MINNEAPOLIS.
March 19. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERS' SOC. OF WESTERN PENNSYLVANIA.
March 20. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
March 20. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
March 20. Secy., F. W. Hart, Washington, D. C.
BOSTON SOCIETY OF CIVIL ENGINEERS.
March 21. Secy., S. E. Tinkham, 36 Bromfield St.
CENTRAL RAILWAY CLUB.
March 28. Secy., S. W. Spear, Buffalo, N. Y.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
SOUTHERN & SOUTHWESTERN RAILWAY CLUB.
April 19. Secy., S. A. Charpiot, Macon, Ga.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
MASTER MECHANICS' ASSOCIATION.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

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AND

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The date when the subscription expires is on the address label on each paper; the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

We are able to announce that the proposal of the Phoenix Bridge Co. for the construction of a bridge over the Mississippi River, at New Orleans, has been accepted by the Southern Pacific Co. The river will be crossed by a cantilever structure with two 608-ft. anchor spans and one central span of 1,070 ft. The viaduct approaches will be of spans varying from 25 ft. to 150 ft. as the height of the supporting towers increases. The total length of metal superstructure will be about two miles and it will be double-tracked throughout.

The channel span of this bridge will be the longest truss span in the world except the 1,700-ft. spans of the Forth bridge. The channel span of the Memphis bridge is 790 ft. The Eads bridge, at St. Louis, has a central span of 552 ft. 6 ins., slightly longer than the central span of the Poughkeepsie bridge, 548 ft. The New Orleans bridge, taken as a whole, will certainly be entitled to rank second to the Forth bridge only among the great bridges of the world.

Elsewhere in this issue we give particulars of the recent letting of an important contract for water tube boilers by the city of St. Louis. We allude to it here partly on account of the extraordinarily low price at which the contract was awarded, but chiefly to call attention to the premium system of drawing specifications, which was adopted in this case, and to which the very low figure at which the contract was let was undoubtedly due. Without repeating the particulars elsewhere given, we will say that the city of St. Louis specified that these boilers should show an efficiency of 65% and that for each 1% increase in efficiency over this requirement a premium of about $1 per horse power should be paid; or if the requirement were not reached, then for each 1% deficiency the same amount should be deducted from the contract price. We have elsewhere shown that the fuel saving by this 1% increase in efficiency will effect a yearly economy equal to the interest on two or three times the premium which the city of St. Louis offered. It cannot be claimed therefore that the premium is excessive, and it appears from the prices offered that the bidders so reduced the amount of their bids that all the premium they are likely to earn will no more than give them a fair profit on their contract. Of course the method of letting contracts was assailed in the sharp controversy which accompanied the letting, but no one was able to present any really valid argument against it. We discussed the system of offering premiums for high efficiency in the award of naval contracts in our issue of Feb. 8. It is a system well worth the careful study of those intrusted with the letting of contracts of very many classes, and we are pleased to note that its adoption at St. Louis has had in this case such excellent results.

The opinion seems to be rapidly gaining ground that it is against public policy to grant perpetual franchises and that the term of all franchises should be made short enough to allow for periodical readjustments of the relations between the public and the franchise holders. At Erie, Pa., recently, the Select Council passed an ordinance limiting the life of any franchise which may be hereafter granted involving the use of the city streets to 25 years.

In all the larger cities, moreover, the practice of obtaining some revenue (for the city, not for the aldermen) from every franchise granted is rapidly becoming established. At a recent meeting of the Commercial Club of Chicago the subject discussed was "Upon What Terms Should the City Grant Franchises for the Use of Streets and Alleys?" It was noticeable that not one of the speakers questioned the right, the wisdom or the feasibility of obtaining a revenue from franchises. These things were regarded as entirely settled, and the question was in what manner the franchises could be disposed of to inure most to the benefit of the city and its people. The corporation counsel of Chicago, Mr. Harry Rubens, in opening the debate, proposed the creation of a "Board of Examiners" composed of an attorney familiar with corporation law, an engineer, and a business man. It should be the duty of this board to examine all franchises introduced into the City Council, and report the result of their examination prior to action upon them by the Council. He also laid down the following principles which should govern the granting of all franchises in large cities: (1) No franchise should be granted except on condition that the city should receive a stated percentage of the gross receipts, and the company offering the highest percentage of the gross receipts should receive the franchise. (2) A cash deposit, proportioned in size to the magnitude of the enterprise should be required as evidence of good faith. (3) At the expiration of every franchise the fixed plant of the company operating under it should become the property of the city. Among the other speakers were Hon. Aldace F. Walker, who urged that in chartering new street railways the franchise should provide for a periodic readjustment by the courts of the rates of fare charged. Mr. John S. Miller, ex-Corporation Counsel, favored ownership by the city of all fixed structures in its streets, including street car lines, electric conduits and pipes for gas, water, etc.

We are aware that in these days of scanty work and small profits our construction news pages are scanned pretty closely by engineers and contractors and the selling agents of supply houses; and to prevent mistakes and losses by those who rely on these pages for information it seems well to give such readers a word of caution in this prominent place. The information from which the news in these pages is compiled comes to us either in the shape of correspondence, or as items in the hundreds of daily newspapers which reach this office from all parts of the country. A vast amount of sorting, sifting and condensing is necessary in order to present each week the largest amount of fresh news of current interest and value without occupying undue space. From the source of the information and its character, we are generally able to form some opinion as to its reliability, and careful readers of our news columns will observe that it is our rule to use some qualifying clause in every case where we cannot be sure as to the accuracy and authenticity of a news item. Thus such phrases as "It is reported," "Press dispatches state," "A local paper says," "A correspondent informs us," etc., in our construction news are intended to give our readers a clue as to the origin of the information from which our item is made up, and are always notice that this journal does not vouch for the accuracy of the statements made.

It will be apparent on a little thought that this is the only method by which we can render our readers the best service. To omit news of enterprises of doubtful character would greatly curtail the value of our weekly news columns, for almost every new enterprise has to pass through its doubtful stages, and we are sure none of our readers would wish us to delay publication of the news of all enterprises until their success was assured, for when this position is reached the opportunities for profitable employment and profitable contracts are mostly gone. It is our aim, therefore, to publish the news and all the news, as promptly as possible, indicating by such brief "guide-boards" as space permits what is mere newspaper rumor and what is reported directly to us by correspondence.

To illustrate the advisability of noting carefully the manner as well as the matter of our construction items we quote the following item from our issue of Feb. 1:

CHICAGO, UNION CITY & CINCINNATI.—It is stated that Foster, Bailey & Keefer, Huntington, Ind., have been awarded a contract for building ten miles of this proposed road, noted Jan. 4.

We gave this item on the strength of a press dispatch which was printed in prominent newspapers of Indiana and Illinois and which definitely stated that a contract had been let as above. Now, every one familiar with the ins and outs of railway financiering knows that the letting of a contract such as that described may mean anything or nothing (the same thing may be said of much of the news which comes to us in the daily papers). It will be further noted that the news item in our columns opened with the qualifying clause, "it is stated." Notwithstanding this, a correspondent writes us from Union City, Feb. 6, that he went to that place on the strength of the item in Engineering News and found that both Union City and Huntington were filled with subcontractors and laborers who had been brought there by the published information, which proved to be false.

We regret exceedingly that any one should be deluded by false hopes based on anything which appears in these columns; but in these times when opportunities for employment and profit are so limited, we must in the interest of our readers publish all the news of new work that comes to us, indicating as best we may what is reliable and what should be accepted with much salt; and relying on our readers' caution and common sense to make investigations for themselves wherever prudence dictates.

The term of office of Com. N. H. Farquhar, as Chief of the Bureau of Yards and Docks in the Navy Department, expires on March 6 ensuing, and we cannot resist the temptation to again speak of the propriety of placing a member of the civil engineer corps of the United States Navy at the head of this bureau, especially as the members of this corps have themselves now petitioned the President to follow this course. This bureau is in all things a civil engineering bureau, having in charge, at the various yards, the design, construction and care of property of an engineering character valued at about $50,000,000, a sum equal to the total cost of our "new navy" to date. There are eight bureaus in the Navy Department, and excepting only the Bureau of Yards and Docks, they all have at their head an officer who is selected because of his especial fitness, training and experience in the detail of the especial work the bureau has in charge. Line officers are properly placed at the head of the three Bureaus of Equipment and Recruiting, Navigation and Ordnance; but a Chief Constructor controls the Bureau of Construction and Repairs; an Engineer in Chief heads the Bureau of Steam Engineering; a Paymaster-General is at the head of the Bureau of Provisions and Clothing and a Surgeon-General heads the Bureau of Medicine and Surgery. And why in the name of commonsense and good government should not a Chief Engineer head the Bureau of Yards and Docks? If this Chief of a Bureau has any duty to perform it is to pass judgment upon engineering plans, to direct the movements of civil engineers and to see that the government funds are best and most economically expended upon engineering works. This duty is entirely outside of the curriculum of line officers and they do

not even pretend to this knowledge. They simply "head" the bureau and leave the actual work of the office to be performed by the oldest and most experienced engineer of the corps. This is altogether wrong and it is to be hoped that the good sense of the President will lead him to see that both justice and the better conduct of public affairs demand a change from the traditional practice of placing a line officer in a position that he is not properly qualified to fill. The civil engineers of the navy are now fully recognized as officers, as much so as surgeons, paymasters, steam engineers and naval constructors. In the case of each of the other four classes mentioned, the Chief of Bureau is selected from the especial class of officers with which the bureau has to deal; and the same should be done for the civil engineers.

The law of 1881, assigning relative rank to the civil engineers in the United States Navy, made their status precisely similar to that of all other officers in the navy, and, under the existing law, makes them eligible to the position of Chief of the Bureau of Yards and Docks. Sec. 422, of the Revised Statutes, simply requires that the President shall select this chief "from the list of officers of the navy, not below the grade of commander," and the preceding section, relating to the chiefs of bureaus generally, says that these officials shall be selected either from the class of officers specially designated, or "from officers having the relative rank of captain in the Staff Corps of the Navy, on the active list." As officers in the Civil Engineer Corps of the Navy hold rank up to and including that of captain, there can be no doubt of their elegibility to the office here referred to. The fact that line officers have always heretofore filled this important office, and doubtless still desire to hold onto it, alone stands in the way of putting a civil engineer at the head of a civil engineering bureau. The law itself should be changed so as to clearly define the class of knowledge and experience required in the chief, as is already done in the sections of the Revised Statutes relating to the four other technical bureaus. This Bureau of Yards and Docks especially require a head who fully and clearly understands his whole business, and as no obstacle except lack of precedent stands in the way of this much-to-be-desired end, it is time the President removed this obstacle.

PUMPING COAL TO MARKET.

In the extreme northeast corner of the Mining Building, at Chicago, last summer was an exhibit which probably attracted little attention from most visitors, since there was nothing to be seen but a circuit of pipes connected with a pump which rarely ran, and a few bottles of black dust and water standing on a table. The whole exhibit was labeled with the title of this article, or its equivalent, but from the very nature of the proposed process such an exhibit could do little more than to excite curiosity, not to gratify it. A few may have picked up the bottles in their normal quiescent state, which was to be a little more than half full of coal dust and a little less than half full of yellowish water, and have been surprised to see by how slight a shake this mixture could be transformed into a kind of black milk, and how slowly it returned to its former state by settling, but no circulars were on hand for distribution and they could have gathered little more light than this on the spot, except from their own reflections.

Yet it seems to us quite possible that this modest exhibit may yet prove to be the most important exhibit in the nature of a prophesy, as distinguished from accomplished fact, in all that vast collection, holding a position in regard to it somewhat analogous to that of the telephone at the Centennial; which latter attracted hardly any general attention at the time and only later came to be recognized as the most notable of all the exhibits. As an evidence of inventive power, indeed, the telephone is a far greater achievement, but in practical utility to man it may easily prove of far less importance than the exhibit we refer to.

The proposition which that exhibit embodied was in brief, this: To reduce all coal at the mines to the form of impalpable dust at a cost of 3 to 5 cts. per ton; to strip it by some of the present washing processes of all free sulphur, pyrites, slate, etc., at the cost of another 5 cts. per ton; to mix it with about its own weight of water, thus converting it into a sort of black milk, and in that state to pump it any desired distance to any desired market as oil is now pumped; there to strip it of most of its water in great settling basins, still leaving from 10 to 20% of water in the mixture, and in that state to pump it short distances only to points of consumption, where the remainder of the water may be dried out by the otherwise waste heat.

When this proposition is examined in detail it certainly seems to have much in its favor and little against it.

In the first place, experience with oil has well determined that the process of pumping through pipes anything which can be pumped is vastly cheaper than any other form of land transportation, especially when the liquid pumped is of such a nature as to furnish power for its own pumping. That coal dust and water makes a liquid which can be pumped was conclusively shown by the sample bottles referred to, their contents after shaking being to all appearance as fluid as milk or clear water. As compared with oil there is the disadvantage that only half the weight pumped is "live load" instead of all of it, but on the other hand, the probable quantities to be pumped are very much larger, giving proportionately greater economy of pumping. It is claimed, and we think with reason, that piping either coal or oil in large quantities and with steady demand costs less than one-tenth of rail transportation. In any event the difference is very great in favor of pumping, which is all we need consider.

That coal dust should mix well with water necessarily results from the fact that it is so nearly of the same specific gravity. Coal in all its forms is almost the lightest of minerals, and its lighter forms are but slightly heavier than water. The following comparative specific gravities illustrate these facts:

Sandstones.	2.0 to 2.7	Anthracite, solid,	1.4 to 1.6
Bricks,	2.0 to 2.2	Bituminous "	1.2 to 1.3
Salt, sulphur.	2.0	Cannel "	1.2
Clay,	1.92	In lumps, heaped:	
Brickwork,	1.8	Anthracite, heaviest	0.9
Dry, loose earth,	1.1 to 1.3	" lightest	0.8
" shaken "	1 3 to 1.5	Bituminous,	0.8
Moist packed "	1.4 to 1.6	" lightest	0.7

The specific gravity of dry coal dust should be even less than of coal in heaps. It will be obvious from these specific gravities that impalpable coal dust should separate from water very slowly, as, for instance, when pumping was stopped, and should mix again very freely when stirred by renewal of pumping or otherwise. Such is claimed to be the fact.

Pure coal of any kind has also little or no grit. As all American and most English coal goes to market it contains a good deal of grit, but the more thrifty Continentals, with their dearer coal, are now in the habit of washing coal at the mines to free it from these earthy materials and find a profit in doing so, the saving in transportation and gain in prices being several times the cost of washing. In this way, it is alleged, the ash and clinker in the coal is reduced from 10 to 15 to 3%, at a cost of 3 cts. per ton in plants of 500 tons per day, and 2 cts. per ton in plants of 1,000 tons. It is obvious that when the coal is to be mixed with water anyway, for transportation, the washing process is made still more expedient; and being thus washed, the claim seems to us reasonable that the wear on the pipes will not be so considerable as to make a serious item in the cost of transportation, though doubtless it will be a sensible item, and not infinitesimal, as with oil or water.

The capacity per day of 24 hours of a 24-in. pipe with a mean speed of five miles per hour is about 31,000 long tons, taking the coal conveyed at 35 lbs. per cu. ft. of mixture. At 1,200 lbs. pressure for pumping stations 30 miles apart (equivalent to a head of about 82 vertical ft. per mile), the calculated tonnage capacity per day for various sized pipes is as follows:

Size.....	4 ins.	8 ins.	12 ins.	18 ins.	24 ins.
Tons.....	320	1,921	5,120	13.760	28.16)

The total coal consumption of New York city is now considerably under 25,000 tons per day, or 9,150,000 tons per year. The New England states burn about 50% more than this; the whole United States nearly 20 times as much, in round figures. It will be seen that comparatively few pipes would suffice to handle enormous quantities of coal.

The entire present wastage from slack or culm is of course a credit charge under this plan. This is large with both anthracite and bituminous, but especially with the latter. D. K. Clark gives the following as about average experience with bituminous coal at English mines, for output at the mines. Anthracite has a much smaller loss by breakage, but loses a still larger percentage of its value by breakage:

	Per cent.	Rel. value.
Good round coal.....	46	100
Small, through ⅝ in. bars.....	21	70
" " ¼ " "	18	57
" " ⅛ " mesh	15	34
Total and average.....	100	76

This shows a loss in value from breakage of 24% at the mines, in addition to which there is a further breakage loss of 5 to 10% at least before the coal reaches the consumer. In addition to the direct saving by avoiding this loss there should be some reduction in the cost of mining due to having no longer any motive for keeping down the proportion of slack. The effort to do so unquestionably adds largely to the cost of getting the coal, but how much can only be guessed at.

There are no useful ingredients of coal which are in any degree soluble in water, or in any degree injured by the mere act of pulverizing. Any bituminous coal exposed for many months to air loses about half its value, and as the tendency to spontaneous combustion is increased by moisture, probably the rapidity of this loss is increased by moisture, as it certainly would be by pulverizing. Moist, pulverized coal exposed to air would probably deteriorate with great rapidity and be extremely liable to spontaneous combustion. So long as protected by enough water to exclude all the coal from contact with the air, however, this tendency should be held in check indefinitely, we should judge. If not, the coal could only be pulverized and delivered as needed, which in any case would naturally be the plan, since storage is cheaper at mines than at points of consumption.

We now come to what will naturally be regarded as the most serious difficulty of the plan, as it probably is, viz., freeing the coal from the water after delivery. Here we reach some surprising results, which the inventor himself does not seem to have had in mind. Supposing we do not free it at all, but burn it just as it comes from the pipes, half water, half coal? It is surprising how little loss results, though such a plan of course is not to be recommended.

To vaporize 1 lb. of water, supposing it to be received at 60° and discharged with the waste gases of combustion at, say, 452° F., requires the following amounts of heat:

To heat the water from 60° to 212°.....	151 B. T. U
To vaporize the water at 212°	965 "
To superheat the steam to 452° (sp.heat 0.475)	114 "
Total.....	1,230 B. T. U

One pound of good coal generates some 14,500 B. T. U., inferior coal rarely less than 11,000 B. T. U. Therefore, even if we make each pound of coal evaporate an equal weight of water in its combustion we only lose 8.5% of the heat of good coal, and 11% of the heat of poor coal. But so large a waste should be in any case unnecessary. The inventor himself proposes large settling basins covering many acres, about 12 hours being required for tolerably complete settling. But if the process is otherwise feasible, such a slow and clumsy process should be unnecessary after a little experience. Separators on the general principle of the centrifugal milk-skimmers or porous delivery-pipes or both should suffice to extract all the water which will still leave the mixture fluid, and it is said that with only 10 to 20% of water it is still fluid enough to be pumped through pipes for some considerable distance. This would so reduce the heat loss from moisture in the coal as to leave little inducement for incurring expense to remove the rest; but wherever there are waste gases of combustion it should be easy to arrange a dryer which would vaporize all the water, even in the half and half mixture, in which case hardly any motive for removing any of the water would remain. One method of doing this would be by a device analogous to the conical sand dryers for railway use,

perhaps, but many methods might be devised, according to the conditions.

The next issue on which doubt may arise is on the comparative value of coal dust for fuel. For burning on a grade it is commercially valueless, the finest commercial anthracites being sold at the following rates per ton at the mines according to a recent address by Mr. Eckley B. Coxe:

Size.	Range of size.	Price at mines.
Chestnut.....	1¼ to ⅞	$2.75
Pea	⅞ to ½	1.25
Buckwheat.....	½ to ⅜	0.75
Rice.....	⅜ to ¼	0.25
Barley.....	¼ to ⅛	0.10

But when coal is reduced to an impalpable dust, a method of burning it becomes possible to which even the finest of these sizes is wholly unadapted; the coal may be blown in as dust mixed with its proper proportion of air, and no grate at all is then required, any more than for the combustion of a gas, which this mixed coal dust and air practically is, giving a similar flame and being about equally manageable. Many trials seem to indicate that this is the best of all ways of burning coal when suitable combustion arrangements have been made; and these trials seem to indicate further that there is no serious difficulty in making proper arrangements for burning it in any firebox. This is perhaps the weakest feature of the scheme, and yet we see no reason why it should offer serious difficulties, while it should certainly remedy the smoke nuisance, since smoke results only from the fact that, when coal is fired in large lumps, it is practically impossible to supply to each particle of coal its proper proportion of air. In the form of dust the coal is also in admirable condition for the manufacture of fuel or other gas, and we are told that it also makes better and stiffer coke than in its original lump state. A still further advantage, it is alleged, is that iron ores may be reduced to dust and mixed with the coal dust before coking with the result of a much improved product, both in quantity and quality.

These latter claims may or may not be entirely sound; on that we express no opinion; but there seems to be no room for doubt that when coal is burned merely to generate heat in properly designed combustion chambers, it can be burned to much better advantage as dust than in any other form, as also that it can be handled and stored more easily as a stiffish fluid than as a friable solid.

The inventor and owner of the patent on this process is (or was some six months since) Mr. W. C. Andrews, President of the New York Steam Co. His patent was issued March, 31, 1891; No. 449,102. Whether any and if so what progress has been made in applying the process on a large scale since it attracted our attention at Chicago last summer, we do not know. Neither do we know how broad or how sound the patent may be. We see no reason why it should not be sound, for so far as we know the scheme is an entirely novel one: but we have not sought to inform ourselves on either of these points because it did not affect our immediate purpose of discussing the project in the abstract. Except that oil pipe lines are such a pronounced success the plan would hardly be likely to occur even to an inventor, and if suggested would hardly be likely to command much favor. The uncertain elements would be too many. But now that pipe lines are a recognized and well established method of transportation, what would otherwise be the most dubious part of such a scheme, the mere movement of the coal dust and water, ceases to offer any difficulty. All the details of that part of the process are already worked out and reduced to rule, needing only to be copied. The radically novel and hence dubious features, therefore, reduce themselves to two: (1) Can the coal be economically and effectively reduced to dust and mixed with water? and (2) Can the mixture be sufficiently freed from its water, and then burned to equal or greater advantage? It is difficult to see why either one of these questions should not be answered promptly and positively in the affirmative. The saving of loss from breakage and of ash and clinker by washing should surely be much more than the cost of pulverizing and mixing with water, while the advantages of powdered over solid fuel should much more than cover the trifling cost of arranging suitable methods of combustion and freeing the coal dust from water to a sufficient extent. If there were no other advantage promised in the way of money saving, but merely no loss, getting rid of the smoke nuisance would alone make the plan expedient for many cities, such as Chicago, Pittsburg and Cleveland; but there seems to us to be more than a fighting chance of a large money saving in addition. We hope to see the plan tested on a large scale.

LETTERS TO THE EDITOR.

THE EAST PROVIDENCE STAND-PIPE FAILURE.

Sir: In your issue of Feb. 8 Prof. J. W. Porter, of Easton, Pa., has well described the positions of the fragments of the broken stand-pipe at East Providence. The piece marked T in his sketch should be 125 ft. long instead of 95 ft., as it comprised the entire circumference of the pipe at this point, but was shorter on the lower edge. This is an important matter, for it tends to prove that the failure first occurred near the top of this piece, or in the 10th and 11th courses, 55 ft. from the bottom, instead of in the second course, as the professor concludes.

The point A in photograph No. 2 (reproduced herewith as Fig. 1.—Ed.) is the end of the piece T in

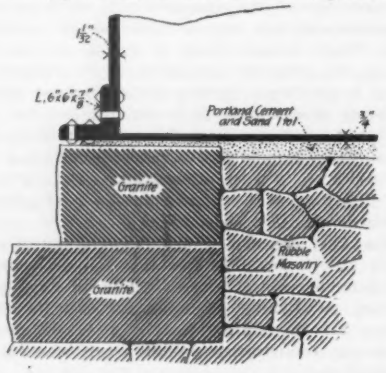

Fig. 2. Sketch Showing Details of Top of Foundation of East Providence Stand-Pipe.

Prof. Porter's sketch. This end coincides with point A, photograph No. 1,* and is in the 10th and 11th courses; the plate marked "B," photographs Nos. 1 and 3, belongs in the 11th course. It seems very evident that the rupture first occurred at or near the point A, photograph No. 2 (Fig. 1). This place presents the appearance of having received a terrific concussion of some kind from the inside. The fractures of the plates at this point radiate in all directions, with the edges rolled outward, as may be seen by the photographs.

It is impossible at this time to formulate any conclusive theory as to the cause of the accident. After the snow and ice are gone further investigations will be made. It could not have been caused by pumping into the tank, for the pumps were stopped two hours previous to the accident. The system is also provided with a safety valve at the pumping station, which would relieve the mains of any undue pressure.

It does not seem possible to have been caused by falling ice at the time, for the pressure gage showed about 100 ft. of water in the tank and the ice was originally formed at 95 ft. from the bottom.

It is hardly probable that the tank received any serious injury to the lower plates during the gales of Aug. 29 and Sept. 7, 1893 (see Eng. News., Sept. 21, 1893.—Ed.), for it was immediately filled with water, and if any such damage had occurred it would have shown itself in the form of leaks, but it was found tight, except in a few spots near the top, where it was blown in. It could hardly have failed, because it was made of steel, for whatever cause broke this pipe would have broken an iron pipe under the same conditions. It is true that the majority of stand-pipes that have failed were made of steel, but according to the reports some of them were known to have been defective previous to the failures.

The sketch (Fig. 2) will show the manner in which the foundation was built. Portland cement and sand, equal parts, were used dry under the bottom plate, and it was brought out to nearly the edge of the angle iron; it was intended to have pointed up around this base after the tank had been filled and found its bearing in the dry cement and sand. However, it had a firm bearing all around under the bottom courses, and this could not in any way have caused the accident.

Yours truly,

Geo. H. Leland, M. Am. Soc. C. E.

Providence, R. I., Feb. 17, 1894.

(The sketch of the foundation of the stand-pipe is similar to that given in our issue of Feb. 8, but more accurate as to detail.—Ed.)

* Photographs 1 and 3 are not reproduced.—Ed.

FIG. 1. VIEW OF PORTION OF WRECKED STAND-PIPE, EAST PROVIDENCE, R. I.

A NEW FORMULA FOR COMPUTING EARTHWORK CROSS-SECTIONS.

Sir: I do not remember to have seen in any fieldbook any account of a quick method of calculating areas of three-level railway cross-sections that I have used to good purpose in practice. The principle of the method may be stated thus: The area of a "three-level" cross-section of the usual form, given the center height c and side heights h and h', differs from the area of the mean height, which is:

$$M = \frac{h + 2c + h'}{4},$$

by the product of the ratio of slope and the square of the difference between the mean height M and the center height S. That is, if S be the true area and S' be the approximate area arrived at by calculating from the mean height M, and r be the ratio of side slopes, we have

$$S = S' - r(M - c)^2.$$

The analytical proof of this formula is easily deduced.

It is remarkable how rapidly areas of this form can be calculated with a little practice by means of an application of this truth, its use being, according to my experience, a decided relief from the monotony and mental drudgery of applying the old set rule which the old field engineers of small erudition and much practical experience delight to tell the novices must be their A B C in the calculation of contents, viz.: The area is: Sum of the side distances into half the center height plus sum of the side heights into one-fourth the roadbed.

Of course it is apparent that to use the above, a table of areas of level cross-section of given slope and roadbed must be made out and another small table for

$$r(M - c^2)^2,$$

which need not be carried further even on comparatively rough work than 4 ft. From these two tables the true area can be found almost as quickly as the mean height can be found.

I am using Mr. Wellington's "Economic Theory of Railway Location" as a textbook in my classes, although the book is not particularly well designed for a textbook for elementary students; but it contains a great deal of practical information that cannot be secured anywhere else. I think a student is apt to gather the idea from the book that any amount of curvature is not a serious objection, though, as I have worked on a road where the author was chief engineer of location, I know that those are not his sentiments. I differ from him very essentially in the idea that it is not necessary to calculate cubic contents by any other method than averaging end areas. I can cite examples in my experience where in a single station the resident engineer was about to estimate to the contractor enough more material than there was in the station to pay for an embankment of same roadbed and slope the full station length and 6 ft. high.

Yours truly,

M. D. Taylor, Prof. Physics and Engineering.

Baton Rouge, La., Jan. 21, 1893.

(The date at the foot of this letter is not an error of one year. Through a combination of mis-

chances for which we owe and tender to the author an apology this letter has slumbered unprinted for an entire year, though it gives a method of computing cross-sections which is certainly novel and ingenious, and it seems to us also the best and simplest method of numerical computation now in use. The areas can be obtained from diagrams still more simply and with all necessary accuracy, but this formula also may easily be adapted to the use of diagrams, and whether by diagrams or tables the factor 27 or 54 may be included in the areas obtained if desired. The peculiar merit of this formula, however, is that it is adapted to very simple and compact tables, which all other formulas known to us are not, and hence that much of the inducement for using diagrams disappears.

As for our correspondent's closing statement, the individual whom he quotes is not conscious of ever having made any such statement except with the important limitation that no difference of center height exceeding 5 ft. between two adjacent sections should ever be permitted in taking field notes, or if permitted in any particular case, then that a "prismoidal correction" from a little table (depending on the differences of center height only) should be applied to that particular solid. With this limitaion, he regards it as easily demonstrable that the simple method of averaging end areas gives a smaller probable error than any other method of computation whatsoever from the same field notes, however elaborate that method may be.—Ed.)

METHODS OF PLOTTING ANGLES.

Sir: While you are on the subject of plotting angles I would like to say that I have recently discarded the protractor for all work requiring accurate projection farther than about 6 ins. from the angle point, depending wholly upon the circle of circumference 360, the radius of which, I may say for the benefit of those who always suspect a quantity stated only to the nearest tenth, is 57.296. I avoid the necessity for drawing either a full circle or a semicircle by carrying always in my pocket, along with a lot of other constants on a small card, the accompanying table showing the chords to the above-mentioned radius, for every 10 degrees from 0° up to 110°. By means of one of these, a 10°

Angle.	Chord.	Angle.	Chord.
1°	0.999	60°	57.296
10°	9.988	70°	65.727
20°	19.890	80°	73.658
30°	29.658	90°	81.020
40°	39.192	100°	87.782
50°	48.420	110°	93.869

point is fixed upon the paper (next less than the required angle, to avoid mistakes in subtraction) and the remainder is laid off, as you say, at the rate of 1 by scale for each degree. In this connection, it is useful to remember that 0° 3′ is equal to 0.05°. Or, if one is used to carrying in his memory the equivalents of inches in decimals of a foot, let him remember that each of these, in the decimal division of the degree, stands for a five-minute mark in the ordinary division.

It will be found nearly as convenient, however, if one has at hand a table of sines to radius 1 (why were they ever called "natural"?), to use these instead. By this method, after laying off 10, 100 or 1,000 to any scale, on one side of the angle, it is only needful to take out the sine of the exact angle required, move the decimal point, and lay off the distance thus obtained, in a direction as nearly square with the other side of the angle as the eye, in connection with the scale and a straight-edge, can determine. For angles much exceeding 45° the chord method will probably be found better.

I wonder how many of your readers have seen the excellent mathematical tables brought out by W. & R. Chambers in their new (1892) edition. They include seven-place tables of sines, chords, arcs, tangents, secants and versed sines, to radius 1, with their complementary functions, "co-arcs" alone excepted, together with good tables of common logarithms and function logarithms, traverse tables, etc. The book costs from $1.25 to $1.75, according to the tactics pursued in buying.

Another innovation which has lately been tried by some in this office is the substitution of tenths or hundredths of a minute for seconds in reading and computing angles, for the sake of convenience in interpolating from tables which run to the nearest minute. With the ordinary graduated circle, and probably with most of the finer graduations, it is as easy to estimate in tenths of a minute as in sixteenths. Ultimately (though this would require the co-operation of the instrument-makers and the publishers) it may be found feasible to use only one unit of circular measure by abolishing the degree.

T. P. Perkins,
Chief Engineer's Office, B. & M. R. R.
Boston, Feb. 11, 1894.

SALARIES OF ENGINEERS.

Sir: Apropos of your recent remarks on the position of city engineer, it may be of interest to note that the city of Cohoes, N. Y., is now looking for an engineer, and as an inducement for the position to be filled by a novice the munificent (?) salary of $500 per year is offered, with $130 retained for political purposes. Verily, the way of the average municipal engineer is hard! Yours truly, S. B. McKee.

Mineville, N. Y., Feb. 8, 1894.

MODERN IMPROVEMENTS IN STEAM ENGINE DESIGN.

At the meeting of members of the American Society of Mechanical Engineers held on Feb. 14, the subject discussed at the previous meeting (Eng. News, Jan. 18), was continued. Prof. John E. Sweet, who opened the discussion, said in part:

Through the kindness of the various builders I have been able to get a pretty accurate statement of the number, size, kind and power of the various engines of sizes above 100 HP. which were exhibited at Chicago. The list does not comprise the small engines, of which, perhaps, there was 150 HP. all told, nor does it include pumping, air compressing, gas engines, portable or semi-portable.

There were 23 single cylinder engines aggregating 3,700 HP.; 44 compounds, aggregating 21,155 HP.; 8 triple expansion, aggregating 8,425 HP., and one quadruple expansion of 3,000 HP., making in all 85 engines of a total of 36,840 HP. This exceeds the total power of the "Campania" by 7,000 HP., making it probably the greatest aggregation of steam power ever assembled in so small a space.

Comparing the steam engines of the present day with those which were represented by the exhibits at the Centennial, we note the change from single cylinders to compound, triple and quadruple expansion, and the introduction and development of the single balance valve, shaft governor, high-speed engine. But so far as the production of steam from the combustion of coal is concerned, the best of to-day is but little better, if any, than the best of 1876, nor is the average to any great extent better than then. Boilers have been improved so that higher pressures are as safe to-day as the lower pressures were before; and as higher economy is obtainable from high pressure than from low, the modern boiler has contributed its share to the improved economy. Water-tube boilers were wholly employed at Chicago, but that is no gage as to what is the practice of the country and only indicates the tendency, which points as much toward higher pressures, as it does toward the water-tube type, and the water tube is gaining because of its ability to carry the high pressures.

An incredible amount of work has been expended on boiler and engine-room auxiliaries, some of unquestionable and much of questionable merit. Nothing has come to supersede the Worthington duplex steam pump, as its many copies confirm, wasteful as it is said to be in steam economy; and the various forms of steam injectors are mostly modifications of the original, and hold about the same relation to the steam pump that they have for years. There are many new and many modifications of both single-acting and duplex pumps and many modifications of the injector, mostly double, using the principle of the inspirator, but the main improvements have been in the simplifying the operation, including especially devices that make the injector self-starting. Economy in the use of steam, either in the steam pump or injector, does not appear to have made much headway. At least the more economical have not swept the old aside to such an extent as the automatic engine has superseded the slide valve throttling type.

Boiler-feed heaters have taken on new forms, with probable constructive and possible operative advantages, but with little strikingly new in principle, except where heaters and filters are so combined as to better rid the feed water of its impurities before entering the boilers. Treating the water with chemicals and filtering is probably the most recent and advanced change that has been made.

Various new boiler compounds have been compounded, but the advance, if any has been made, is in a wider understanding, that the remedy must fit the disease, just so far as compounds or filters prevent incrustation or contribute to keeping the boilers clean, just so much they have contributed to economy, and if all fixtures were credited with the saving claimed, they far more than make up for the increased boiler efficiency.

Automatic damper regulators, high and low water alarms, sediment pans, automatic boiler feeders, improved grate bars, mechanical stokers, various steam and oil separators and the steam loop have been studied over, changed, improved, perfected or invented and applied during recent years, and these, too, in their way, have contributed to steam economy, but nowhere has the change been more marked or results so advantageous as in the engines themselves.

There is more or less tendency to mix the shaft governor and Corliss valve as shown by three or four different examples, the aim being to retain the good points of the Corliss valve and be able to run at higher speed, a promising scheme.

The Willans engine, while nearly as old as many well known American engines, is new to us and remarkable in many respects, but particularly for its economy in spite of what we have supposed to be detrimental features, throttling, single acting, mechanically fitted valves and high speed. But these defects, whether imaginary or real, are overcome or neutralized, and other advantages come in naturally, so that while at first sight the claims for its economy are questioned, there is a lot of genuine steam engineering in it. Besides the low clearance, free escape for water and no loss from compression, the main thing lies, I believe, in the fact that the steam end of neither cylinder is ever in communication with the one of lower pressure or with the condenser. The growth of the Willans engine has been phenomenal; 20,000 HP. were sold last year. We are prone to joke over the slow, conservative English; but perhaps they know a good thing when they see it after all.

For great power in small space, the claim we make for our high speed engines, it seems to me about an even send off between the Westinghouse, the Willans and that crowning feature of the engine display, the triple expansion 1,200 HP. Schichau engine in the German exhibit.

As shown by the exhibits at Chicago the standing appears in this way. The largest and most economical, and probably as economical as has been thus far built, was the Allis engine, the largest exhibit by any one firm was that of the Westinghouse, both American; the was the Allis engine; the largest exhibit by any one the best piece of steam engineering, the German; the best rotary, Swedish, and the best workmanship, French (the Creusot engine).

As to the future I think we may look forward to using better judgment as to putting the right engine in the right place. There is a right and wrong place, if not for all, at least for several kinds. The claim against the high-speed engine is that it is not economical and terribly prone to smash-ups, but in spite of that it has built itself up and was the means of building up the largest half of the electric light business. As to its wasteful use of steam, that has been overestimated and is fast being improved, and as to the smash-ups, better separators and safety devices and the destructive flywheel accidents of slow-speed engines during the last two years put the boot on the other foot. With the high-speed engine and Mr. Porter came better work, and much better yet is needed and will be demanded, for there is a place for the high-speed simple engine that nothing else can fill. There is, too, a place for the Corliss engine and a place for the compound, though already many of them have been put in the wrong place. There is a place and as yet a good deal of unoccupied space for a vertical direct connected machine and places for the triple and quadruple expansion. There is a show for better designs, a show for better workmanship, especially in castings, and as to the show for improvement in steam engineering, I can only reply as Barnum did when asked what he thought his chances were for heaven. He said "he thought he had the greatest show on earth."

Discussion.

Mr. Robert Cartwright said that for intermittent service, as for situations where steam is used to supplement water power, the higher economy of the Corliss engine was of little importance, and a simpler engine which would stand idle with little care and be ready to start on short notice would be preferable.

Mr. Charles E. Emery said that the Schichau engine, exhibited at Chicago, was a creditable piece of workmanship, but in point of actual performance the best record made by any engine at the Exposition was that of the Lake Erie engine in the power house of the Intramural Ry.

Mr. Wm. Odell said that the Centennial Corliss engine was not the best example of what Mr. Corliss could do in securing high economy. While he was building the Centennial engine he was studying on the plans for the Pawtucket pumping engine, and that has shown about as high a duty as any engine ever built.

Mr. Wm. Kent said it looked as if the epitaph of the small high-speed engine was soon to be written on account of its failure to obtain high economy. The slow-speed Corliss engines also seem likely to be succeeded by the marine type.

Prof. F. R. Hutton said that it was evidence of the rapidity of progress in steam engineering that only 14 years ago the Porter-Allen and the Buckeye were the only two high-speed engines on the market. The criticism of Mr. Strong, at the previous meeting, that stationary steam power plants are too costly is one of much force. Apparently designers of stationary plants can study locomotive practice to advantage.

Mr. Chas. H. Loring said the locomotive boiler for some reason had always been a failure when it was attempted to use it on land or at sea. The only explanation he knew of was that the vibrations of the locomotive on the rails served to disengage the steam from the tube surfaces. Again, no one would think of designing a crank-pin for a stationary or a marine engine with the small bearing surface which is successfully adopted in the locomotive. Perhaps it is the con-

stant motion of the pin in the open air that keeps it cool.

Mr. Platt, of the English firm of Fielding & Platt, said that there had been a tendency in England to adopt marine engines for stationary service, but it is found that there is considerable trouble with the stuffing boxes, as the grit and dust work down into the gland.

Mr. C. E. Emery said that due credit should be given to the late J. C. Hoadley for his share in the development of the high-speed engine. In 1876 he was building a line of portable engines with automatic governors well proportioned to give good regulation and with piston valves. These engines showed a steam consumption as low as 26 lbs. per HP. running non-condensing. His draftsmen were Armington & Sims, and when he got into financial difficulties they finally took his shop. The De Laval steam turbine, exhibited at the Exposition, is a machine of great possibilities. It is said that the inventor is constructing a 5,000-HP. turbine in Sweden, which is expected to surprise the engineering world.

Mr. M. N. Forney said the fact seemed to have been overlooked that the locomotive was the first successful high-speed engine. Mr. Loring ascribed the success of the locomotive boiler to the fact that it is given a certain tremor. If this is true it would be a wise thing to apply a sort of Swedish movement cure to our stationary boilers and keep them in a constant state of vibration while at work. Further, if it is true that it is the revolving in fresh air that keeps the locomotive crank-pin cool, it might be well to use a blower to cool the bearings on stationary engines.

WATER PURIFICATION IN AMERICA.

(Continued from p. 124.)

The Covered Reservoir at Rockford, Ill.

An interesting reservoir with a bold and novel roof was recently put in use at Rockford, Ill. It was built after plans by and under the direction of the city engineer, Mr. Chas. C. Stowell. The reservoir, walls, bottom and roof are of concrete, the latter being built after the Monier system (Eng. News, May 23, 1891, Feb. 16, 1893), and reinforced by concrete ribs, 7 ft. c. to c., resting on angle irons, with the outward thrust on the side walls taken up by tie-rods. Mr. Stowell has sent us the drawings of this structure, reproduced herewith, and also the following description of the reservoir:

The city of Rockford is supplied with water from artesian wells which penetrate two distinct strata of water bearing rock. The first stratum is reached at an average depth of 200 ft. below the surface and is about 180 ft. thick. It is a porous rock cemented slightly, yet sufficiently to stand without support. The second stratum is about 485 ft. below the surface and is composed of alternate layers of standstone and shale of varying thicknesses; its aggregate thickness at this point is not known, although one of the wells reached a depth of nearly 2,000 ft.

There are at present five deep and four shallow wells. The deep wells flow direct to the pumping pit under a head of about 16 ft.; four of these are connected with a 16-in. conduit and one, No. 4 on

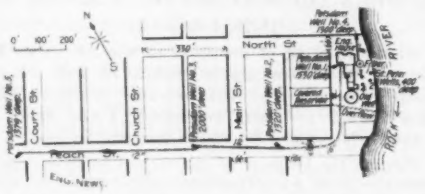

Fig 15. Map Showing Location of Covered Reservoir, Pumping Station and Artesian Wells at Rockford, Ill.

the map, Fig. 17, flows through an 8-in. pipe to the pit. All of the deep wells are cased through the upper stratum, St. Peter's rock, and get their supply from the lower or Potsdam rock. The shallow wells do not flow, the head normally being but little more than the level of the water in the pit. Deep well pumps are placed in these wells and the water carried into the 16-in. conduit, leading to the pit.

The entire supply is pumped from the pit direct to the mains, the quantity varying from 2,000,000 to 3,000,000 gallons per 24 hours. During the periods of greatest consumption it was found that the combined supply from all the wells would not meet the demand, while at other periods, perhaps of the same day, the flow from the deep wells alone was sufficient. The necessity for a storage reservoir was seen and the writer was instructed to design and construct one of from 1,000,000 to 1,250,000 gallons capacity into which the water from the shallow wells could be pumped and delivered to the pit as desired. The lot on which it was to be built was $66.3 \times 156\frac{1}{2}$ ft., situated near the pump house, about 210 ft. from the river. The surface of the front of the lot was about 10 ft. above the ordinary surface of the river and the back of the lot about 6 ft. higher than the front. The soil was known to be a loose gravel, full of water, the head at times being several feet higher than the surface of the water in the river. For this reason it was not thought advisable to put the bottom of the reservoir lower than the surface of the water in the river. This elevation was chosen for the surface of the bottom at the rear with a slope of 6 ins. to the front. Sumps, 1 ft. deeper, were made around the outlet pipes.

Concrete was chosen as the best and cheapest material to be obtained here for the mason work. It was made of 1 part by measure of Portland cement, 2 parts of sand and 5 parts of stone of 2-in. maximum diameter for a height of 12 ft. from the surface of the bottom at the back end; in the remaining 8 ft. Rosendale cement was substituted for Portland. After the walls and bottom were built and trued up, the entire inner surface was coated with ½ in. of plaster consisting of equal parts of Portland cement and sand. A plan and longitudinal section of the reservoir is shown by Fig. 18 and a cross-section by Fig. 19.

The work of placing the concrete was begun at the back end to exclude as much water as possible; and most of the walls, to a height of 10 ft., were constructed before the bottom was begun. A temporary sump was built at the front, near one corner, and a pump placed in it to dispose of the water not excluded by the walls; ditches were cut through the gravel, which were changed from time to time to accommodate the work, all leading to the sump.

The bottom was graded to stakes set 18 ins. below the top of the finished surface. Four rows of tile were then laid about 9 ft. apart, beginning about 8 ft. from the back wall. Three-inch tile were used about one-half the length of the reservoir, then

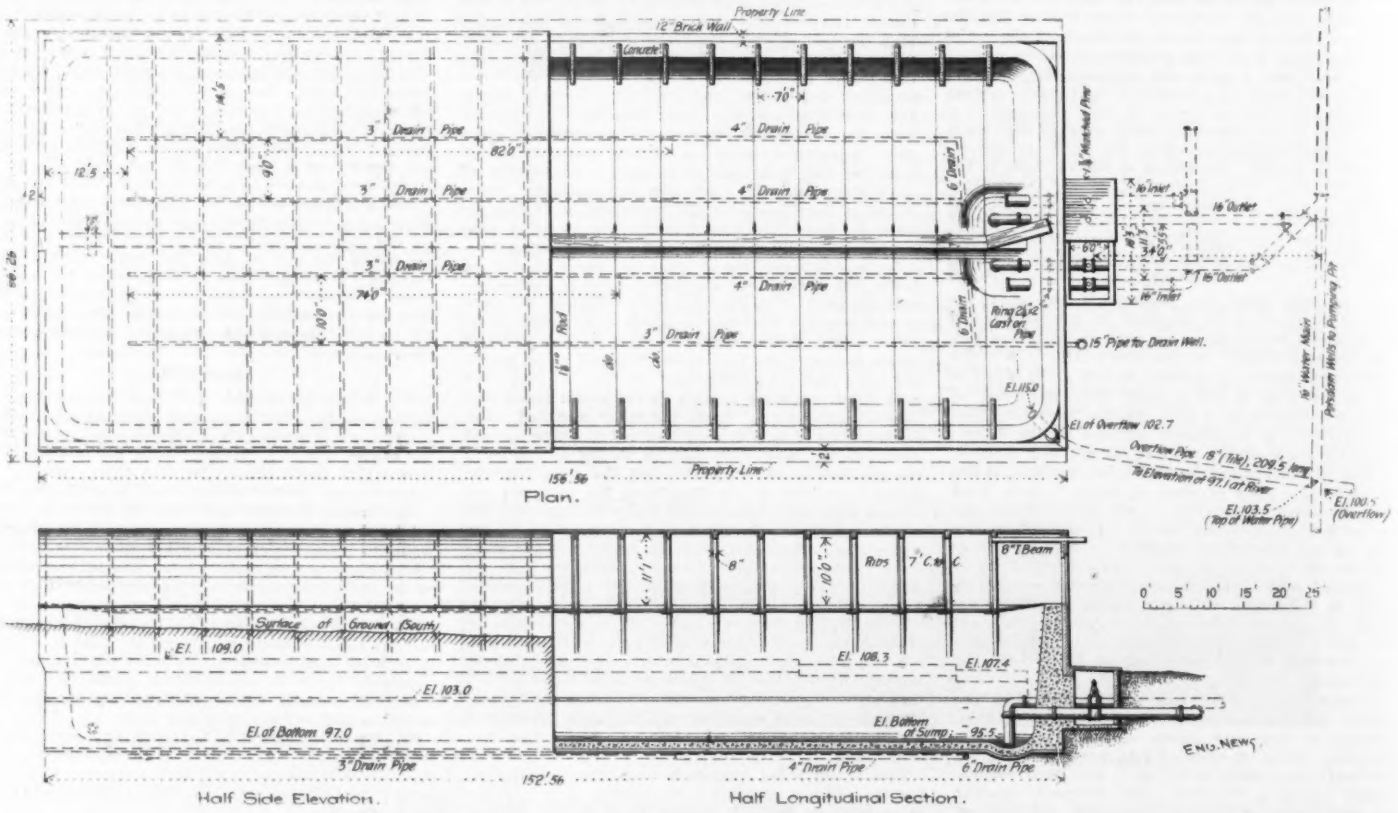

FIG. 18. PLAN AND LONGITUDINAL SECTION OF RESERVOIR.

4-in. to a point about 8 ft. from the front wall, where all four lines connect with a 6-in. tile leading under the wall to a 15-in. sewer pipe carried vertically to the surface of the street and fitted with a cover. The 15-in. sewer pipe is intended to act as a sump for a pump should it at any time hereafter be found necessary to repair the bottom.

The flow line of the tiles was about 1 ft. below the graded bottom. The ditches in which they were placed, which were about 2 ft. wide at the top, were filled with fine broken stone to a level with the graded bottom. A layer of clay 3 ins. deep was spread and made compact by ramming over the

gravel and stone, on which the concrete was placed in two layers, 8 and 7 ins. thick, respectively. After the bottom had sufficiently set, fillets of concrete were built to given radii against the walls and covering the joints between the walls and bottom. Before the finishing coat was spread on the bottom, the concrete was thoroughly cleaned and the bottom flushed with neat cement made into a thin paste with water.

To have the advantages of a double reservoir without reducing its capacity materially, a light wall, averaging 6¼ ft. high, was placed longitudinally through the center and a double set of pipes were carried through the front wall. A pipe with valves was also run through the central wall at the back end near the bottom. The pipes in front were not put on a level with the bottom, but at such an elevation as to connect with the 16-in. conduit leading to the pumping pit, siphonage being depended upon to take the water from the reservoir below the level of the conduit. The valves in these pipes were placed in a chamber in the sidewalk area.

The reservoir walls were made vertical on the outside and battered 1 to 10 on the inside. They were made of the same thickness at any particular height so that the corners were arcs of circles, making the entire work uniform. A 12-in. wall of brick was laid on brackets cast with and a part of the concrete wall, to prevent unequal settling, about 3 ft. below the surface of the ground, as shown in Fig. 19. The brick was intended to give additional strength to that portion of the concrete above the ground, protect it from the weather, add to the appearance of the structure and form the gables. The brickwork at the corners was carried out to a right angle, leaving a space between it and the concrete. In one of these spaces an overflow pipe was placed which leads to the river. The upper end of this pipe passes through the concrete wall with its flow line 2 ft. below the top of the wall. A door was placed in each gable, in the upper part of which "Z" irons were so placed that perfect ventilation would be secured and objectionable matter excluded.

We did not succeed in satisfying ourselves with a design for a roof before advertising for bids on the reservoir, and inserted a clause in the advertisement asking for separate bids on some plan for a permanent roof. Five were submitted, but none seemed entirely satisfactory, the prices ranging between $4,000 and $5,000. We then set about designing a roof on the Monier system, and in looking for proper material had our attention called to the expanded metal lath manufactured by the Northwestern Expanded Metal Co., of Chicago. Samples of this lath were sent us with which we made experiments which satisfied us that it could be used to advantage.* After consulting with Mr. J. F. Golding, of Chicago, the patentee of the expanded metal, the present roof design was adopted and a contract made with him for a much less sum than had heretofore been offered, to construct the roof by a method which he has patented for constructing fireproof floors and ceilings, using the same materials. The expanded metal concrete roof and strengthening ribs are shown by the sketch, Fig. 20.

Falsework was put in place for the entire roof, as shown by dotted lines in Fig. 19. Seven-inch steel channel irons, to form the lower portion of each rib, previously bent to the form shown in the cut showing the section of the reservoir, wrapped with steel lath, were dropped in place. The ends of each channel rest on ½-in. cast iron plates set in niches cast in the concrete 7½ ft. below the top of the wall. The object of the lath around the channel iron is to give support for cement plaster which is to cover the channel iron as soon as all falsework is removed, which will be some time this coming spring.

The spaces in the falsework left for the ribs, which were about 7 ft. c. to c., were filled with concrete and the expanded metal for the roof stretched over and stapled to the plank of the falsework. Concrete composed of 1 part of Portland cement, 2 parts of sand and 5 parts of fine gravel was spread over the whole to a depth of 1½ ins. A finishing coat of ½ in. was then used, composed of 2½ parts of sand to 1 part of Portland cement. Tie-rods 1¼ ins. in diameter with turnbuckles

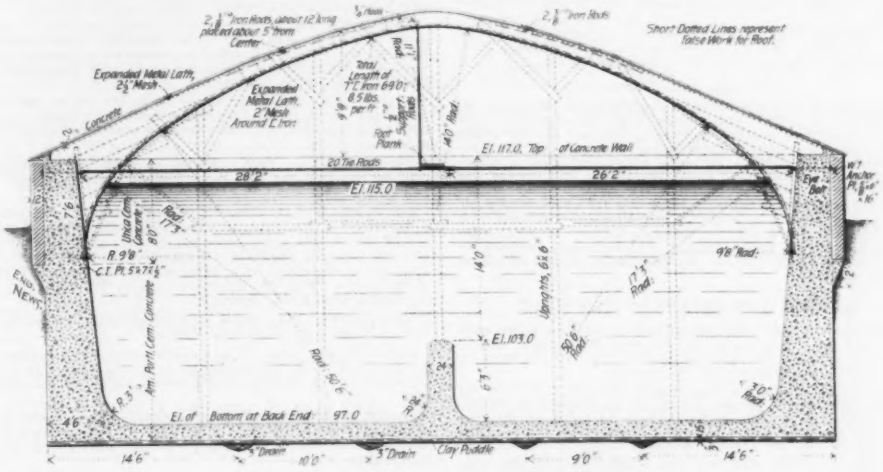

FIG. 19. CROSS-SECTION OF RESERVOIR.

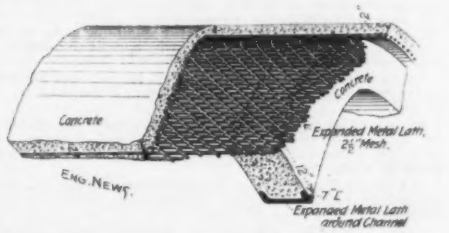

Fig. 20. Method of Constructing Roof with Concrete and Expanded Metal Lath.

near the middle were passed through the concrete wall, close up to each rib, 1 ft. below the top of the wall and riveted to plates ⅝ in. thick, 6 ins. wide and 16 ins. long.

The reservoir was completed about Sept. 1, 1893, and cost about $17,600, exclusive of roof and lot.

The annual report for 1893 of Mr. Stowell, as city engineer, gives the detailed cost of the reservoir, excluding the roof, as follows, the work having been done by contract:

6,143.8 cu. yds. excavation at $.50	$3,072
86.2 cu. yds. clay puddle, 2.50	216
11.0 cu. yds. crushed stone, 2.50	28
1,274.92 cu. yds. Portland concrete, 6.50	8,287
348.2 cu. yds. American concrete, 4.00	1,392
1,891.54 sq. yds. finishing coat, .75	1,419
104,551 brick, $20 per M	2,092
Total	$16,506

The cost of the roof is given as $2,000 in the same report, making the total cost of the structure $18,506.

For lightness of construction the Rockford roof may be compared with the tile roof at Waltham, Mass. (Eng. News, Dec. 21, 1893), the former having a span of about 56 ft., a thickness of 2 ins. at the crown, but reinforced by 12-in. concrete ribs, while the latter has a dome with a clear span of about 42 ft. and a thickness of 3 ins. at the crown, but entirely without reinforcement.

The thrust of the Rockford roof is taken up, in part, by tie-rods, while at Waltham the reservoir extends outside the circular part, affording what are practically buttresses to take up the thrust.

The relative costs of the two roofs were approximately 23½ cts. at Rockford and $1.38 at Waltham per sq. ft. of surface covered. While the two roofs may not be strictly comparable, there remains after making liberal allowances a large balance in favor of the concrete roof.

A GRAVITY SYSTEM FOR HANDLING COAL.*

By Tyler Calhoun, Superintendent Whitwell Colliery.

At Thomas mines, Whitwell, Tenn., the necessity for much costly machinery has been avoided by a gravity system for handling the coal, draining the mines, etc. The "Sewanee" seam, which is worked here, averages 3 ft. in thickness and lies nearly horizontally under many square miles of the Cumberland plateau, cropping out for over 50 miles along the face of the mountains on the west side of the Seguachee Valley. The mines are 1,100 ft. above and one mile distant from the tracks of the Nashville, Chattanooga & St. Louis Ry., while the mountain extends 300 or 400 ft. above the mines. Mule traction is used for mine haulage, the average haul being ¾ mile, and the output 800 to 1,000 tons per day. Mine cars hold one ton each and the gage of the track is 26 ins. At the mines the work of getting the cars to and from the tipples and dumping them is done mostly by gravity. From these tipples the coal is carried to the railroad chute below by an incline operated entirely by gravity. The total length of this incline is 4,700 ft. and its rise 1,035 ft.; the maximum grade is 46% and the minimum grade 14%. The track is of the three-rail type, with a four-rail passing place at the middle. It is of 4 ft. gage, laid with 30-lb. steel rails. At each "trip" two cars 5½ tons each, go down, both fastened to one end of a 1¼-in. Hewitt interlocked wire rope, which passes over 8-in. cast iron rollers, spaced 40 ft. apart, and is wound 3½ times around each of two 7-ft. drums at the top of the incline. At the other end of the rope two empty cars are drawn up, as the two loaded ones go down. These cars are shaped to have horizontal tops on the slope of the incline. In addition to the ordinary coupling they have safety chains to take the weight in case of accident. The cars are controlled by a powerful hand brake at the drum, their speed being regulated automatically by two fans, the shafts of which carry pinions that gear with spur wheels on the drum shaft in such a ratio that the resistance of the air on the fans balances the motive power of the incline when a speed of 1,200 ft. per minute is attained. Ten trips per hour are made. At the foot of the incline the cars are uncoupled from the wire rope and run out 500 ft. to the railway chutes. There they are dumped by dropping their bottoms, and run back to the foot of the incline, practically by gravity.

The coal, after leaving the incline, passes, by gravity, over a series of short screens, with a drop of 6 ins. from each screen to the next, the screens being set on a general slope of 30° and fitted with diamond top screen bars. The "fine" coal falls into a bin here, while the rest passes into a chute 54 ft. long and lined with steel plates; half way down this chute is another screen, with 3-in. spaces, which takes out the "nut" coal, the "lump" coal passing directly down the chute. Thus the screening and loading on railway cars are accomplished by gravity. The railway tracks in the yard and on the scales are also graded for operation by gravity.

The "fine" coal passes through eyes in the bottom of the bin into five-ton funnel-shaped cars, which are run by gravity out on a track on top of the coke-ovens, into which the fine coal is dropped. For draining the mines two siphons are used, each 1,200 ft. long, one 2 in. and the other 3 in. diameter, both discharging 300 ft. from the summit and 25 ft. below the level of water in the sump. They are primed by one man without stoppage.

Gravity is utilized inside the mines also in bringing down the coal. The men undermine a few feet and allow their work to remain during the night, when it is found that by morning the settling of the roof will bring down the coal. In 207,094 tons output in 1893 the powder used averaged one keg per ton of coal.

* See Eng. News, Dec. 7, 1889, "Some Appliances for Fire Protection," for a description of metallic lathing put on the market by the Central Expanded Metal Co., of Pittsburg, Pa., which appears to be the same as that used at Rockford.

* Abstract of a paper presented at the meeting of the Engineering Association of the South, Nashville, Tenn., Feb. 8.

There is no steam boiler or engine about the works. The ventilation is effected by furnaces. The surplus energy consumed by the regulating fan and that available by the descent of the drainage water 1,000 ft. suggests further application of this accommodating and economical force—gravitation.

CONSTRUCTION NEWS.

(Readers are invited to contribute items concerning new construction of interest to engineers or contractors for insertion in these columns. Those using these pages for information are informed that announcements of calls for proposals are inserted but once, and are not repeated from week to week.)

RAILWAYS.

East of Chicago—Existing Roads.

BALTIMORE & OHIO.—A press report from Washington states that John Dugan, Georgetown, D. C., is engaging help for an extension of the Metropolitan Southern branch of this railway from its present terminus near the Chain bridge, whence it has been extended from Linden, on the Metropolitan branch, to Fairfax Court House, Va., en route to a connection with Richmond; work including a bridge across the Potomac River, above Georgetown, and the construction of a tunnel.

CLEVELAND, LORAIN & WHEELING.—The time for receiving bids for the 28 miles of construction between Cleveland and Mallet Creek, O., has been postponed from Feb. 20 to March 1, as stated in our advertising columns. Ch. Engr., W. C. Jewett, Cleveland, O.

OHIO SOUTHERN.—A press report from Springfield, O., states that Mayor Cobb, Ch. Engr., has commenced surveying for an extension of this railway between Bainbridge and Chillicothe to connect with the road to be built from Portsmouth to Columbus.—The northern extension, just completed to Lima, will probably be continued to Toledo this summer.

OLD COLONY.—The city engineer of Boston has signed, for the city of Boston, the final plans for elevating the tracks of the Providence division of this road from West Chester park to just beyond Forest Hill station. There will be four tracks; overhead bridges will be of iron; estimated cost, $2,500,000.

PENNSYLVANIA.—It is reported that the building of a branch line to the steel works of the Johnson Co., at Johnston, Pa., is apparently assured.

WEST VIRGINIA CENTRAL & PITTSBURG.—Press reports state that all financial arrangements have been completed and that contractors are being conferred with relative to the construction of this railway from Cumberland to Hagerstown, Md., about 78 miles. Ch. Engr., Chauncey Ives, Hancock, Md.

Projects and Surveys.

COAST RY. OF NOVA SCOTIA.—It is reported that engineers have arrived at Yarmouth, N. S., to make surveys for this railway, noted Jan. 18, and that the construction of the line will be pushed as rapidly as possible.

WASHINGTON & CHESAPEAKE BEACH.—Coffin, Sullivan & Co., Washington, contractors for this railway, are reported as ready to contract for ties, track supplies, iron supplies for bridges and for about 7,000 ft. of trestles.

Southern—Existing Roads.

MIDDLE GEORGIA & ATLANTIC.—Press reports state that the money has been raised to complete this railway between Covington, Ga., and Milledgeville, and that it is confidentially expected that the road will be extended so as to make an air line between Atlanta and Savannah. Ch. Engr., Arthur Pew, Eatonton, Ga.

SUMTER, LAKE CITY & CONAWAY.—H. W. Mackey, Pres., Sumter, S. C., is reported as stating that 10 miles of this road will be built at once. The grading has been commenced.

Projects and Surveys.

POINT PLEASANT, BUCKHANNON & TYGART'S VALLEY.—It is reported that an election will soon be held in Upshur county, W. Va., to vote on an issue of $40,000 of bonds to aid this proposed railway, which is projected as a connecting line between the West Virginia & Pittsburg at Buckhannon, and the West Virginia Central & Pittsburg at Belington, W. Va.

ROANOKE MINERAL BELT.—G. W. Crumpecker, Roanoke, Va., attorney for this company, is reported as securing the necessary rights of way and as stating that the road will be built from that city to the nearest accessible point with Richmond & Danville as soon as possible.

Northwest—Existing Roads.

CENTRALIA & CHESTER.—This road is now in operation from Sparta to Centralia, Ill., and press reports state that efforts will be made to extend it to Salem, Ill., this summer. Gen. Man., G. P. Roseborough, Sparta, Ill.

VANDALIA.—A press report from Decatur, Ill., states as follows: It is learned here that the Vandalia Ry. Co., which recently leased the Terre Haute & Peoria line, has had plans prepared for building an independent track from the Central bridge, south of Decatur, along the east side of the Illinois road through the city to Maroa, 13 miles north. The improvements will necessitate the building of a new union depot.

Projects and Surveys.

GRAND ISLAND & NORTH WYOMING.—The Secretary of the Interior has approved a map of the amended definite location of this railway, granting the right of way over public roads on its route.

Southwest—Existing Roads.

TEXARKANA & FORT SMITH.—A press dispatch from Texarkana, Tex., states as follows: The work of filling of the gap of 40 miles between Allene, the northern terminus of this railway, and Siloam Springs, the southern terminus of the Kansas City, Pittsburg & Gulf, will be pushed to completion. The two roads will be consolidated by the Missouri, Kansas & Texas Trust Co., and extended from this place to Sabine Pass, on the Texas coast. A branch is also to be built in Shelby county, Tex., on the main line to New Orleans. The stockholders and directors were in this city Feb. 10 and decided on the extensions.

Projects and Surveys.

KANSAS.—It is reported that H. A. Sturgis, Topeka, has completed surveys for a railway seven miles in length from Highland to Ryan, on the St. Joseph & Grand Island. The commercial club of St. Joseph, Mo., is said to be interested in the project.

MISSOURI, OKLAHOMA & TEXAS.—This company has petitioned for authority to build a railway through Oklaboma, the route, according to press reports, being from the southwest corner of Missouri westerly to the eastern corner of Beaver county, Okla., with one or more branches.

ST. LOUIS, AVOYELLES & SOUTHWESTERN.—It is reported that contracts for grading this proposed railway, recently noted, will probably be awarded next month. Pres., F. M. Welch; Secy., E. H. Cochran; Ch. Engr., Ira W. Sylvester, all of Alexandria, La.

Rocky Mt. and Pacific—Existing Roads.

CANADIAN PACIFIC.—The Seattle "Post-Intelligencer" states as follows: J. G. McLean has just returned to this city from the Kootenai country, where he has completed a contract on the Nakusp & Slocan R. R. He says that the whole 32 miles of the road is ready for rails as far as Three Forks, and that the bridges are built. On the Revelstoke & Arrow Lake, which will connect with the Nakusp & Slocan by means of steamers on the Arrow lakes, track is laid on 10 miles of the road, four miles are under construction, and the contract for the remaining 14 miles will be let in a few days.

WASHINGTON & SOUTHERN.—It is reported that J. G. McLean, Seattle, has commenced work on a five-mile branch of this road near Shelton, Wash.

Projects and Surveys.

DELTA, WESTMINSTER & EASTERN.—A press report from Victoria, B. C., states that the city council is considering a resolution indorsing the bill of this company, now before the legislature. The plan of the promoters of the road is to build a railway from English Bluff, Gulf of Georgia, to Westminster city, cross the Fraser River with a combination railway and traffic bridge, and finally connect with the Great Northern at the United States boundary. The Vancouver Island link of the new road, the Victoria & Sidney, is now complete, and a fast ferry steamer will transport passengers and freight coaches from the Vancouver Island terminus to the mainland.

STREET AND ELECTRIC RAILWAYS.

LEWISTON, ME.—The Lewiston & Auburn horse railway has been sold to E. B. Proctor, Wakefield, Mass., and others, and the motive power will be changed to electricity. Gen. Man., E. W. Gross.

WATERBURY, Vt.—The Mount Mansfield Electic R. R. Co. has been incorporated by E. D. Blackwell, W. P. Dillingham, L. C. Moody and others to build an electric railway between this place and Stowe, 10 miles. The town of Stowe has already voted a bonus of $40,000.

MIDDLETOWN, CONN.—The Middletown St. Ry. will be changed to an electric line, according to reports.

NIAGARA FALLS, N. Y.—Burt Vanhorn, representing the Niagara Whirlpool & Northern Ry. Co., has given notice that he will ask for a franchise for an electric railway in this place, for which the money is said to have been already subscribed.

COLLINGWOOD, N. J.—A franchise has been granted to the Camden Horse Car R. R. Co.

ELIZABETH, N. J.—The Suburban Ry. & Electric Co. has been incorporated by W. B. Hosmer, Boston; James B. McGiffert, Roselle; C. H. Newhall, J. S. Bartlett, Lynn, Mass.; capital stock, $750,000. The company will carry on its operations throughout Union county, and will have its main headquarters in this city.

WOODBURY, N. J.—A franchise has been granted to the Camden, Gloucester & Woodbury R. R. Co. The ordinance calls for the paving of all streets where double tracks are used with 17 ft. of Belgian blocks and 10 ft. of the same material where single tracks are used. Work will be commenced on the road as soon as the weather will permit, and extensions will be built to Paulsboro and Almonerson at an early day.

BRADFORD, PA.—The Valley R. R. Co. has been incorporated; capital stock, $150,000; Pres., Chas. A. Weed.

HOMESTEAD, PA.—The Streets Run & Homestead R. R. Co. has been incorporated to build a street railway 1½ miles in length; capital stock, $15,000; Pres., John F. Cox.

MAYFIELD, PA.—The Lackawanna Valley St. Passenger Ry. Co. has been incorporated; capital stock, $100,000; Pres., Wm. Walker.

NORRISTOWN, PA.—It is reported that Messrs. Speffs, who controls the Citizens' line, are receiving bids for important electric railway extensions.

OXFORD, PA.—The Pennsylvania Traction Co. has been granted a franchise through this town.

PHLADELPHIA, PA.—The Huntingdon St. Connecting Passenger Ry. Co. has been incorporated; capital stock, $6,000; Pres., Geo. D. Widener.

PITTSBURG, PA.—The Brady's Bend & Butler R. R. Co. has been incorporated to build a railway from East Brady to Fairview; capital stock, $120,000; Pres., Chas. O. Billings, Boston, Mass.

POTTSTOWN, PA.—Arrangements are being made to construct the electric line to Ringing Rocks as soon as possible, according to reports.

WALURBA, PA.—The citizens are reported as raising funds to secure an extension of the Wilmerding & McKeesport Electric Ry. to this town.

ROCKVILLE, MD.—There is serious talk of extending the Bethesda electric railway to this place, according to press reports.

CHARLOTTESVILLE, VA.—It is reported probable that work will soon be commenced on the proposed electric railway, for which a franchise has just been granted.

IRONTON, O.—R. T. Greave, Lynchburg, Va., is reported as having arrived in this city to superintend the construction of the new electric railway.

WARREN, O.—A corporation with a capital stock of $10,000 has been formed to construct a railway between the towns of Kinsman and Farmdale in this county. Electricity, steam or cable power is to be used. The incorporators are D. M. Yeomans, E. R. Brackin, J. W. Forbes and J. A. Russell.

YOUNGSTOWN, O.—Bids are asked until March 3 for the construction and operation of two routes. J. H. Edwards, Cy. Clk.

INDIANAPOLIS, IND.—The Farmers' & Broad Ripple St. Ry. Co. has been incorporated to operate an electric line from this city to Broad Ripple, and possibly to Noblesville; capital stock, $100,000; directors, W. R. Myers, Secy. of State; John C. Green, A. N. Fisher, Henry Malpas, Oliver C. Myers.

ROCKFORD, ILL.—The Rock River Electric Ry. Co. has been incorporated with a capital stock of $50,000, to build a railwny from this city to Dixon; J. S. Ticknor, G. E. King, H. B. Andrews, Rockford; J. C. Ayres, Dixon, and Fred. G. Jones, of Oregon. J. S. Ticknor, Gen. Man. West End Electric Ry. Co., Rockford, is reported as the leading spirit in the enterprise.

ONALASKA, WIS.—Press reports state that the La Crosse & Onalaska St. Car Co. will increase its capital stock from $30,000 to $50,000 and change its motive power to electricity.

SHEBOYGAN, WIS.—A. E. Thomas is president of a company formed to construct a street railway from this place to Sheboygan Falls.

INDEPENDENCE, IA.—The Independence & Rush Park St. Ry. Co. has been incorporated with a capital stock of $25,000.

SIOUX CITY, IA.—The Sioux City Cable Ry. Co. is reported to have notified the council of its acceptance of the ordinance granting the company the right to use electricity on its line.

TAMA, IA.—The Tama & Toledo Electric Ry. & Light Co. has been incorporated; capital stock, $80,000.

LEAVENWORTH, KAN.—The long discussed ordinance granting Newman Erb, Receiver Leavenworth Electric Ry. Co., a franchise to construct an electric railway has been passed by the council and agreed to by Mr. Erb, according to reports.

ST. LOUIS, MO.—The Missouri R. R. Co. is reported as about to complete its belt line, for which it secured a franchise several years ago, and to equip it as an electric line.

TEXARKANA, TEX.—There is talk of building a dummy line to the business college one mile east of the town.

DENVER, COLO.—The El Dorado Land Development & Mining Co. has been incorporated with a stated capital of $1,000,000, to operate an electric plant and street railway system in Taos, Rio Arriba, Colfax, Santa Fe and Mora counties, New Mexico, with principal offices in this city. The stockholders are: J. W. Shannon, G. A. Smith and J. M. Young.

OAKLAND, CAL.—Bids are asked until March 19 for certain street railway franchises.

OROVILLE, CAL.—The Underground Sealed Conduit Ry. Co. has been incorporated by L. C. Pressley, L. G. Crossley, E. O. Rollins and others; capital stock, $500,000.

GALT, ONT.—Reports state that a charter has been obtained for an electric railway to Preston and that the construction of the road will be commenced at an early date.

ELEVATED RAILWAYS.

PHILADELPHIA, PA.—The councils' committee has approved the plans for the proposed Market St., Richmond & Frankford Elevated Electric Ry.

CHICAGO, ILL.—The Northwestern, the Metropolitan West Side and the Lake St. elevated railway companies are reported as busily engaged planning for the construction of their respective lines, previously noted in these columns.

BRIDGES AND TUNNELS.

BOSTON, MASS.—The mayor has signed the order authorizing the $750,000 loan for a new bridge to Charlestown.—The contract for constructing the abutments of the Cottage Farm bridge has been awarded to Leavitt, Daley & Crockett, Boston, at $40,150, the other bids being Metropolitan Const. Co., $41,022; R. A. Malone & Co., $42,000; G. M. Atkins & Co., Palmer, $46,200; Miller & Wakeman, $46,781; O'Connor & White, $47,139; Jno. Sutherland, $48,873; Jos. Ross, $48,900; Blaisdell & Cashman, $49,250; Jones & Meehan, $49,320; L. K. Marston, $54,000; Perkins & White, $54,500; A. Rowe, $56,318; W. H. Ward, Lowell, $67,281; Turnbull & Ryan, $78,281; W. S. Sampson, $78,493.

CAMBRIDGE, MASS.—The council is considering the rebuilding of two bridges and the construction of a new bridge across the Charles River.

WHEELING, W. VA.—It is reported that surveys are being made for a tunnel under Tenth St.; estimated cost, $75,000.

AUGUSTA, GA.—A. H. Davidson, Cy. Engr., can give information concerning two iron bridges to be erected here.

INDIANAPOLIS, IND.—The city engineer is preparing plans for a bridge over Pleasant River, at Madison Ave.

GRAND RAPIDS, MICH.—The board of public works has been directed to secure estimates for two iron viaducts.

OMAHA, NEB.—The Omaha Bridge & Terminal Co. is reported as planning to build a steel viaduct a quarter of a mile in length, estimated to cost $100,000, plans to be ready in about 30 days.

WACO, TEX.—The council is considering the construction of a new bridge across the Brazos River, and it is stated that the question of location will be decided at the coming city election.

WATER-WORKS.

CONCORD, N. H.—The city has sold $50,000 of 4% water bonds for $51,666.

MANCHESTER, N. H.—The aldermen are considering a resolution appropriating $5,000 for investigating the question of an additional supply.

ST. JOHNSBURY, VT.—A special meeting will probably be held soon to consider the report of the trustees on the question of works.

ABINGTON, MASS.—The commissioners are reported to have decided that a new pump is necessary at the Big Sandy station; estimated cost, $14,000, one-half to be paid by the town of Rockland.

BARRE, MASS.—The legislature will be petitioned for a charter for a company proposing to put in works, according to reports.

BOSTON, MASS.—The water board will receive bids

until March 5 for stop-cocks, and until March 6 for iron and brass castings.——The city engineer has prepared plans for a series of 22 filter beds, covering 500,000 sq. ft., to be constructed in a brook near Marlboro Junction, to protect basin 3 of the water supply system.

CHARLEMONT, MASS.—There is talk of putting in works.

DANVERS, MASS.—The commissioners are reported as about to recommend the construction of a new 700,000-gallon reservoir; estimated cost, $5,000.

GLOUCESTER, MASS.—At the mass meeting Feb. 15 the citizens voted, 258 to 58, in favor of petitioning for authority to construct works to be owned by the city.

NEWBURYPORT, MASS.—The report of Percy M. Blake, Engr., has been submitted to the council. New works are recommended with a supply from Artichoke River; total estimate, $370,000.

QUINCY, MASS.—The council has voted an appropriation of $60,000 for extensions.

ROCKPORT, MASS.—The town wishes authority to put in works.

RIDGEFIELD, CONN.—John F. Gilbert writes us that no action has been taken for works since securing a charter, except to have surveys and estimates made; population, 2,500.

WATERBURY, CONN.—R. A. Cairns, Cy. Engr., writes us that the contract for laying section 1 of the 36-in. cast iron conduit has been awarded to Martin Lipps, New York, at $35,637, the bids for sections 1 and 2, respectively, being as follows:

Troy Public Wks. Co., Troy, N. Y.	$45,846	and	$59,072
Continental Const. Co., New York	43,198		.....
John W. Gaffney & Co., Waterbury	51,225	and	57,725
Waterbury Const. Co., Waterbury	46,888	and	54,326
A. H. Coon & Sons, Kingston, Pa	36,531	and	41,339
Edward McManus, Waterbury	45,22?	and	43,459
Flynn & Sullivan, New York	40,531	and	49,927
Martin Lipps, New York	35,637	and	46,794
Francis Curnan, Rhineback, N. Y.	42,708	and	57,150
Inman Bros. Const. Co., New York	39,307	and	45,081
A. W. Byrne, West Medford, Mass.	59,470	and	72,163
Lucien A. Taylor, Boston	48,953	and	51,395
Jos. Long, South Braintree, Mass	.....		51,555
McCusker Bros. & Co., Waltham, Mass.	.....		62,856
Daniel O'Connell & Son, Holyoke, Mass	.....		54,491

WOODBURY, CONN.—A. W. Mitchell, Secy. Woodbury Water Co., writes us that no contracts have yet been awarded for works, which will include about three miles of 6-in. pipe and a reservoir. Engr., B. H. Hull, Bridgeport.

ALBANY, N. Y.—The lowest bid for 450 tons of 20 to 3-in. pipe was that of the Warren Foundry & Machine Co., at $10,320.

COXSACKIE, N. Y.—Surveys are reported as being made for works. Edwin Mackey, Secy. Comrs.

FREEPORT, N. Y.—Bids for $35,000 of bonds are asked until Feb. 23, and for constructing works until March 6.

LOCKPORT, N. Y.—C. H. Cornes, Cy. Engr., writes us that the contract for enlarging the plant from 5,000,000 to 8,000,000 gallons capacity has been awarded to the Holly Mfg. Co., at $6,800; work to consist of new water wheel, etc.

NIAGARA FALLS, N. Y.—E. Z. Burns, Cy. Engr., writes us that plans are being prepared for the extensions for which the citizens recently voted to issue $50,000 of bonds.

SYRACUSE, N. Y.—Bids are asked until March 16 for about 1,700 ft. of 36 to 4-in. cast iron pipe, as stated in our advertising columns. W. R. Hill, Ch. Engr.

SYRACUSE, N. Y.—It is reported that about seven miles of cement pipe will be replaced with cast iron pipe early in the spring.

CAMDEN, N. J.—L. E. Farnham, Cy. Engr., writes us that the improvements being made by the government in the Delaware River at Philadelphia will necessitate laying a new intake and perhaps a change of the pumping station of this city.

JERSEY CITY, N. J.—Bids are asked until Feb. 26 for furnishing and laying 18,500 ft. of 12-in. cast iron pipe. Geo. T. Bouton, Clk. Comrs.

OCEAN GROVE, N. J.—It is stated that the Interlaken, Belmar & Spring Lake Water Co. has made a proposition to furnish a supply of filtered water.

SOMERVILLE, N. J.—The Somerville Water Co. will put in 10 additional hydrants and make extensions, according to reports.

ARDMORE, PA.—Works are proposed.

CURWENSVILLE, PA.—H. B. Thompson, Supt., writes us that the company is considering about three miles of extensions, but has not yet ordered the work.

ELIZABETH, PA.—The local press urges that works be put in this year.

GETTYSBURG, PA.—The water company has engaged W. H. Deckant, Reading, as engineer of proposed scheme to secure a supply from Marsh Creek.

McKEESPORT, PA.—It is proposed to lay a 24-in. main from the pumping station to the Monongahela River.

OIL CITY, PA.—A. M. Breckinridge, Clk. Bd., writes us that the city proposes to erect two iron tanks but is not yet ready for bids.

SALTSBURG, PA.—Bids are asked until March 10 for constructing works, as stated in our advertising columns. Robt. H. Wilson, Engr.

SHERIDAN, PA.—Press reports state that the citizens of this place and Stouchsburg are talking of forming a company to put in works.

TOWER CITY, PA.—It is reported that new works are contemplated.

WILMINGTON, DEL.—Surveys are being made along the Brandywine River, near Chadsford, Pa., for a storage reservoir, according to reports.

BRUNSWICK, MD.—The city has petitioned for authority to issue $40,000 of bonds for works.

ELLICOTT CITY, MD.—The city has petitioned for authority to issue $30,000 of 6% bonds to put in works, supply to be from springs near by.

BIG STONE GAP, VA.—The works will be sold in May. They were built in 1891 and have been in charge of a receiver since last June.

CHARLOTTESVILLE, PA.—The council is considering a resolution in favor of issuing $25,000 of bonds for improvements. Some think that a pump, to cost $2,000, would be sufficient.

NORTH DANVILLE, VA.—It is reported that the city desires works and is willing to grant a franchise.

AIKEN, S. C.—J. W. Baum has prepared plans for works.

AUGUSTA, GA.—P. S. North, Clk., writes us that a stand-pipe is to be erected.

NEWNAN, GA.—N. W. Davis, Atlanta, is preparing plans for a 225,000-gallon stand-pipe, according to reports.

VIENNA, GA.—It is reported that there is talk of putting in works.

TALLAHASSEE, FLA.—The water company is reported to have contracted with the Tifflit & Wood Mfg. Co., Phillipsburg, N. J., for a steel stand-pipe 100 ft. high.

BIRMINGHAM, ALA.—The council has appointed a committee to confer with the water-works company with a view to purchasing the works.

NEW IBERIA, LA.—It is stated that Gales & Craig wish to correspond with water-works contractors.

NEW ORLEANS, LA.—The "Picayune" states that the present supply is far from satisfactory and recommends that the water company secure a supply from the Bogue Falia, in St. Tammany parish.

BROWNSVILLE, TENN.—The council has been authorized to contract for the construction of works, according to reports.

FAYETTEVILLE, TENN.—W. D. Nudecris is reported as wishing to correspond with parties concerning works.

TULLAHOMA, TENN.—Efforts are being made to secure works, according to reports.

FRANKFORT, KY.—The Seckner Contracting Co., Chicago, has been awarded a contract for pipelaying amounting to $45,000.

AKRON, O.—It is reported that the council is considering the purchase of the works, as the present contract has about expired.

JEROMESVILLE, O.—M. L. Hosler, Clk., writes us that the citizens have voted in favor of proposed works and that there is talk of putting in wooden pipe; no work will be done until April.

LOCKLAND, O.—The contract for works has been awarded to D. R. P. Dimmick, at $19,585.

MANSFIELD, O.—An election will be held April 2 to vote on an issue of $30,000 of bonds for extensions.

NELSONVILLE, O.—Bids are asked until March 13 for works, including about 35,000 ft. 12 to 4-in. cast iron pipe, well 30 ft. in diameter and 1,000,000-gallon pumping engine. A. E. Price, Clk.

NORTH AMHERST, O.—Works are projected, according to reports.

ORRVILLE, O.—H. S. Wertz, Vil. Clk., writes us that bids will be received until March 13 for works, including two 600,000-gallon pumping engines, 375 tons 10 to 4-in. cast iron pipe, laying 4½ miles of mains, etc.; estimated cost, $25,000. Engr., Alexander Potter, Pittsburg, Pa.

TIPPECANOE CITY, O.—It is stated that more wells will be sunk.

WINTON PLACE, O.—The city of Cincinnati has refused to furnish a supply to this village, or to other adjacent villages hereafter, unless it shall become a part of the municipality.

YOUNGSTOWN, O.—The trustees have directed that meters be purchased and put in such places as the superintendent may direct.——It is reported that two stand-pipes, two new pumps and larger mains will be added.——The question of issuing $186,000 of bonds for improvements will be voted upon again at the April election.

HAUGHVILLE, IND.—The ordance prepared by the water company for a supply provides for 41 hydrants at $50 each per year.

INDIANAPOLIS, IND.—The council is again considering the question of purchasing the plant of the water company.

LEBANON, IND.—The Lebanon Water-Works Co. has been incorporated by C. W. Scott, W. O. Darnell, S. Artman and others; capital stock, $20,000.

MARTINSVILLE, IND.—The city has sold $18,000 of bonds for putting in works.

BAY CITY, MICH.—Geo. Turner, Cy. Engr., writes us that the city is awaiting the results of the experiments with wells at Saginaw before taking steps to improve the supply, noted Feb. 8.

DETROIT, MICH.—The fire commission has petitioned for extensions estimated to cost $30,510.

DOWAGIAC, MICH.—W. M. Vrooman, Mayor, asks us to state that no extensions are under contemplation in this city.

GRAND RAPIDS, MICH.—Fred. A. Twamley, Secy. Bd. Pub. Wks., writes us that the date for the opening of bids for a 15,000,000-gallon pumping engine has been postponed until Feb. 27.

CARLYLE, ILL.—It is stated that the water company has offered to sell its plant for $26,000.

EARLVILLE, ILL.—The question of works will probably be voted upon at an early date, according to reports.

JACKSONVILLE, ILL.—A proposed dam is estimated to cost $11,747 and a 16 or 12-in. main $5,745 or $4,379, respectively.

MARENGO, ILL.—The injunction to prevent the city from putting in works and an electric light plant has been dissolved.

WAUKEGAN, ILL.—The council is reported to have passed an ordinance for works estimated to cost $70,500.

APPLETON, WIS.—Geo. M. Conway has reported that the plant is in an unsatisfactory condition, and the committee has recommended that steps be taken to secure new works, to be owned by the city.

KENOSHA, WIS.—Bids are asked until March 19 for the construction of works, as stated in our advertising columns. O. M. Pettit, Mayor.

REEDSBURG, WIS.—The lowest bid received for building the new works was that of the Seckner Contracting Co., Unity Bldg., Chicago, at $27,000.

WAUPACA, WIS.—The town is reported as willing to grant a franchise.

CEDAR RAPIDS, IA.—The franchise of the water company expires in February, 1895, and the city has given notice that it will purchase the plant at that time. J. D. Blain, Cy. Recorder.

GRINNELL, IA.—The city has engaged Geo. C. Morgan, Chicago, to superintend the purchasing of material and construction of works, the cost not to exceed $25,000.——The remaining $15,000 of bonds have been sold for $15,305 net.

INDIANOLA, IA.—A town meeting was held last week to discuss the question of works.

RIVERSIDE, IA.—Works are proposed, according to reports.

TRAER, IA.—An election will be held April 5 to vote on an issue of $9,000 of bonds for works.

ALDEN, MINN.—The question of issuing $5,000 of bonds for works will be voted upon next month.

HIBBING, MINN.—The Hibbing Light & Water Co. has been incorporated by Frank Hibbing, L. E. Judson, Jr., and J. L. Washburn, Duluth, and has been granted a 30-year franchise for works and for gas and electric plants; capital stock, $50,000.

MINNEAPOLIS, MINN.—The council has ordered the construction of a 24-in. submerged pipe across the Mississippi River.

CHANUTE, KAN.—Bids are asked until March 20 for constructing works, as stated in our advertising columns. J. W. Buchanan, Cy. Clk.

COFFEYVILLE, KAN.—The council and mayor are reported as at odds over the granting of a franchise to W. P. Brown.

LAWRENCE, KAN.—The circuit court has appointed Elias Summerfield, Rookery Bldg., Chicago, receiver of the Kansas Water & Light Co., which operates plants at this place and Peola, Kan.

LEBANON, KAN.—It is reported that works are being agitated.

GRAND ISLAND, NEB.—It is stated that a new 3,000,000-gallon pump is much needed.

TOPEKA, KAN.—Elias Summerfield, Chicago, has been appointed receiver of the Topeka Water Co.

NORFOLK, NEB.—The city has issued $40,000 of bonds and purchased the works, according to reports.

BISMARCK, N. DAK.—C. B. Little, Pres. Bismarck Water Co., has been appointed receiver of the company.

BUFFALO, WYO.—Bids are asked until March 31 for the construction of a gravity system of works. W. H. Fenn, Cy. Clk.——It is reported that the works of the Buffalo Mill Co. have been purchased by the city for $8,282.

CASPER, WYO.—The contract for works has been awarded to the Michigan Pipe Co., Bay City, Mich., for the $30,000 of bonds voted last season. A dam will be built in Elkhorn Creek.

LANDER, WYO.—The council has voted to submit to the citizens at the election in May a proposition to issue bonds and grant a franchise to some company, according to reports.

ODESSA, MO.—The mayor is reported as stating that the city is figuring on works.

ROCKPORT, MO.—W. R. Luttell, Supt., writes us that the city has three 6-in. wells 70 ft. deep, but the supply is insufficient and bids are wanted for increasing it.

ST. LOUIS, MO.—Bids are asked until March 6 for ironwork required at basins 1 and 2 at Chain of Rocks.

BASTROP, TEX.—The Bastrop Water & Light Co. has applied for a charter and will put in works at once, according to reports.

CORSICANA, TEX.—It is reported that $12,000 has been subscribed toward boring an artesian well, and that a new water company will be organized.

JASPER, TEX.—It is stated that works will probably be put in.

SHERMAN, TEX.—It is stated that more mains and another deep well will be added.

TERRELL, TEX.—It is stated that a new pumping engine will be purchased.

WEATHERFORD, TEX.—E. P. Nicholson is chairman of a committee appointed to consider the question of works.

EVANS, COLO.—The citizens are reported as agitating the question of works and electric lights.

SANTA FE, N. MEX.—The Santa Fe Water Co. is reported to have decided to construct an additional reservoir, work to be commenced within 30 days. Max Frost, Secy.

PORTLAND, ORE.—Plans are being considered for a dam for a proposed storage reservoir.

ALAMEDA, CAL.—The trustees are considering the question of an additional supply, which is said to be needed at once.

FORT BRAGG, CAL.—It is reported that a supply will be secured from an artesian well and works put in.

OAKLAND, CAL.—The stockholders of the Oakland Water Co. will vote April 5 on an issue of $800,000 of bonds to pay indebtedness and for extensions.

SAN FRANCISCO, CAL.—The Spring Valley Water Co. is reported as negotiating for a site for a reservoir to supply residents of Clarendon Heights, Bernal Heights and Holly Park.

CANNING, N. S.—R. M. Kinsman, director, writes us that a gravity system has been completed.

MIDDLETOWN, N. S.—The town has petitioned for authority to purchase works.

ARTESIAN WELLS.

WASHINGTON, D. C.—Bids are asked at the office of Indian Affairs until April 10 for drilling one artesian well each on Pine Ridge, Rosebud and Standing Rock Indian reservations, in South Dakota. D. H. Browning, Comr.

BOONE, IA.—Bids are asked until March 14 for sinking an artesian well, as stated in our advertising columns. Jesse L. Hull, Cy. Clk.

SCOTT CITY, KAN.—G. W. Blakely wishes to correspond with capitalists and contractors of artesian wells, according to reports.

CORSICANA, TEX.—The committee on water-works has recommended that a company with $30,000 of capital stock be formed to sink three artesian wells.

STEPHENVILLE, Tex.—Work will soon be commenced on an artesian well, according to reports.

IRRIGATION.

O'NEILL, NEB.—Judge M. P. Kinkaid is reported as interested in an irrigation scheme which contemplates the construction of 90 miles of ditch.

GREELEY, COLO.—Press reports state that work is about to be commenced upon the enlargement of the Greeley and Loveland canal, which will be enlarged so as to nearly double its present irrigating capacity.

SANTA FE, N. MEX.—The Santa Fe Water & Irrigation Co. is reported as about to commence the construction of a large reservoir for irrigation purposes.

SPOKANE, WASH.—The "Review" states as follows: The Northern Pacific, Yakima & Kittitas Valley Irrigation Co. will construct 150 miles of irrigation laterals in the Yakima Valley before May 1. Three surveying parties will be put in the field immediately to run the surveys and establish grades and other preliminary work. The field of work will be the company's holdings between Ziliah and the end of the main canal, which is about eight miles northeast of Maton, on the Northern Pacific R. R. The laterals are to be finished by May 1, owing to the company having sold land under contracts binding itself to furnish those buying the land with water by that time. The main ditch of the canal has been built 42 miles from where the headgates open out of the Yakima River, eight miles below North Yakima. It and the laterals which have been constructed have cost the company $700,000. The work was begun in the spring of 1891. Over 20 miles of the canal remain yet to be built, which, when finished, will bring a total of 75,000 acres of arid land under cultivation.

SAN JACINTO, CAL.—It is reported that the San Jacinto and Pleasant Valley district will extend its canal about six miles.

BOISE CITY, IDAHO.—The "Statesman" states as follows: R. A. Cowden, Emmett, reports that the Payette canyon canal is now an assured fact. Articles of incorporation were brought over for filing, and work on the canal will be commenced in a few weeks. When finished the canal will be 15 miles long, and over $100,000 will be expended in building it. The canal will cover 25,000 acres of fine bench land not covered by the Last Chance canal.——W. C. Bradbury, Denver, has purchased the New York and Phyllis canals, which were sold last week to satisfy a judgment of $170,000 held by Mr. Bradbury himself. It is thought that the New York canal will be extended as originally pojected.

NEW COMPANIES.—Settlers Ditch Co., Sweet, Idaho; $10,000; Pres., John Tally; Secy., Wm. Carpenter.——Pleasant Ridge Ditch Co., Sacramento, Cal.; $20,000; H. J. Goethe, A. Meister, M. Miller.——Mutual Ditch Co., Redington, Neb.; $10,000.——Clayton Irrigation Co., Clayton, Kan.; $28,000; J. W. Leichliter, J. M. Kirk.——Ironstone Short Line Ditch Co., Delta, Colo.; $4,000; Geo. Jackson, Dan Cook, H. Bear.——Salt Creek Irrigating Ditch Co., Durango, Colo.; $100,000; Edgar Bates, Robt. Morrison, Owen Boyle.

SEWERS.

FORT FAIRFIELD, ME.—The board of trade is reported as agitating the question of a system. A. O. French, Secy.

FAIR HAVEN, MASS.—The committee has recommended that an engineer be employed to make surveys for a complete system.

HOLYOKE, MASS.—Bids are asked until March 6 for constructing a brick outlet sewer. R. B. Holmes, Chn. Com.

MILFORD, MASS.—The "Gazette" recommends the immediate construction of a system. Several years ago it is stated that surveys were made, but no steps for a system have been taken since then.

BUFFALO, N. Y.—The contract for constructing a sewer from Cazenovia Creek to Meridan St. has been awarded to Wm. Franklin, at $40,700, who also has the contract for a sewer in Essex Ave.

WEST NEWTON, MASS.—Bids are asked until March 8 for 2,250,000 brick, 10,000 bbls. cement, 38,560 ft. of 24 to 4-in. sewer pipe, etc., as stated in our advertising columns. H. D. Woods, Cy. Engr.

MERIDEN, CONN.—The city engineer is reported as stating that about $40,000 will be spent for sewers.

WATERBURY, CONN.—Bids were received for the outfall sewer from J. W. Gaffney & Co., at $5,770, and Edward McManus, at $5,067.

GENEVA, N. Y.—The state board of health has approved the plans of J. J. Croes, New York, for a system. Two outlets into Seneca Lake are proposed, and it is thought that one, to cost $7,000, will be built at an early date. The work will probably be done as required, without issuing bonds. D. B. Backenstose, Pres. Com.

LOCKPORT, N. Y.—Chas. H. Cornes, Cy. Engr., is preparing plans for a 20-in. tile drain in Green St.; plans to be ready about April 1.

CRANFORD, N. J.—The committee has reported that it would probably cost $50,000 to $75,000 to construct an outlet sewer to tide-water. A sewer large enough for this town, Westfield and Linden is proposed and would cost about $150,000.

MILLVILLE, N. J.—It is reported that the council has adopted plans for a system, and that if they are approved by the state board of health, the construction will probably soon be commenced.

NEWARK, N. J.—Bids are asked until Feb. 26 for constructing 15-in. pipe sewers in two streets. Chas. Marsh, Supt. Pub. Wks.

CHESTER, PA.—The citizens will vote on issuing $30,000 of bonds for sewer work, according to press reports.

ERIE, PA.—The city engineer has prepared estimates for several sewers.

CUMBERLAND, MD.—The council is considering the construction of a system; length, 12 to 14 miles; estimated cost, $35,000.

LYNCHBURG, VA.—The council is considering an ordinance for building two sewers estimated to cost $30,000 to $40,000.

RICHMOND, VA.—The finance committee has asked for an appropriation of $70,000 for sewers.

CHARLESTON, S. C.—The committee has reported in favor of systems of pipe sewers in separate districts and the adoption of the Shone hydro-pneumatic system or a modification thereof. It is proposed to divide the city into eight or nine districts and to construct sewers in one or two districts each year without issuing bonds. The commission has recommended that Capt. R. E. Hartford be engaged to complete the plans and S. M. Gray as consulting engineer. T. G. Simons, M. D., Chn. Com.

COLUMBIA, S. C.—Plans have been prepared, according to reports, for a system, estimated to cost $176,895, but the report states that the part needed at present can be constructed for about $40,000.

BRUNSWICK, GA.—We are informed that the council has unanimously adopted the plans for a complete sewerage system prepared by Waring, Chapman & Farquhar, Newport, R. I., who will superintend the construction, and has awarded a contract for about 21 miles of the construction to Herbert Tate, New York, at $160,000. Work will be commenced at once and six miles must be finished by June 1, 1894, when work will be suspended under an ordinance prohibiting turning up the soil in the hot summer months. The balance of the work will be done next winter. The system provides for a single central pumping station, the sewage being pumped through a cast iron force main into the channel of Turtle River.

MACON, GA.—The time for receiving bids for the 42 miles of sewers noted in our issue of Feb. 1 has been extended from Feb. 26 to March 8.

ST. AUGUSTINE, FLA.—The local press is agitating the question of a system.

MONTGOMERY, ALA.—Work will probably be commenced in March or April on about $100,000 of sewer work.

MERIDIAN, MISS.—The mayor is reported as stating that the contract for a system, for which $100,000 of bonds were voted last November, should be awarded by April 1.

LEXINGTON, KY.—The contract for preparing a topographical map has been awarded to Joe Hoeing, at $500. The map will be sent to Col. Geo. E. Waring to be used in preparing specifications for proposed sewer system.

CLEVELAND, O.—Bids are asked until Feb. 28 for constructing sewers in 19 streets; also for house sewer and water connections in 11 streets. J. H. Farley, Dir. Pub. Wks.

GLENVILLE, O.—J. H. Farley, director of public works, Cleveland, has ordered the city engineer to make surveys for a system, and also to make surveys for a system in the East End.

WARREN, O.—It is proposed to build 24-in. sewers in five streets.

YOUNGSTOWN, O.—F. M. Lillie, Cy. Engr., informs us that it is proposed to extend the system, but that no definite steps have yet been taken.

HUNTINGTON, IND.—Bids are asked until March 15 for certain sewer work. H. H. Wagoner, Cy. Engr.

INDIANAPOLIS, IND.—The contract for section 1 of the Mississippi St. sewer was awarded to T. T. Sheehan, at $12 per lin. ft., as stated last week, and that for the work from Georgia to Seventh St., has been awarded to Wm. Bossert, at $90,618, being $7.92 per lin. ft. Other contracts have been awarded to W. C. Allen & Co., at $3.57 per lin. ft., and to the Acme Paving & Contracting Co., at $2.70 per lin. ft.

ST. JOHN'S, MICH.—It is reported that the citizens will vote on issuing $30,000 of bonds for a system.

MADISON, WIS.—McClellan Dodge, Cy. Engr., writes us that the question of sewage disposal, recently noted, will probably be settled within a few weeks. The sewage will require pumping at the outlets of the several districts and being forced through ½ to 2½ miles of pipe to the disposal works.

PORTAGE, WIS.—The council is again discussing an issue of bonds for the proposed system.

RACINE, WIS.—It is reported that contracts will soon be awarded for sewer work to cost about $40,000.

CHICAGO, ILL.—Bids are asked until Feb. 26 for certain sewer work at Dunning, Ill. C. Mamer, Supt., Cook Co. Comrs.——It is reported that the contract for building the last section of the Wentworth Ave. outlet sewer to the Little Calumet River will be awarded to Wilson & Jackson, at $30,020, this being the lowest of four bids received last week for the work.

PEKIN, ILL.—The council has ordered that surveys and plans be made for a complete system.

BOONE, IA.—Bids are asked for until March 14 for constructing about 124,000 ft. of 18 to 6-in. pipe sewers, as stated in our advertising columns. A blueprint showing plans and details will be sent for $5. Jesse L. Hull, Cy. Clk.

CEDAR RAPIDS, IA.—The board of public works has been directed to ask for bids for sewers in two streets.

HOT SPRINGS, S. DAK.—It is reported that plans have been prepared for a system, the main sewer being estimated to cost about $9,500.

YORK, NEB.—Plans have been prepared for a system to cost about $25,000, according to reports.

ST. LOUIS, MO.—Bids are asked by the board of public works until March 6 for constructing eight pipe sewers. Wm. Wise, Asst. Sewer Comr., informs us that more contracts will probably be awarded in April.

SEATTLE, WASH.—The council has voted to construct a main sewer estimated to cost $31,500.

SACRAMENTO, CAL.—The trusteees have proposed a new system, to cost about $100,000. The plan includes a large cess-pool at the outlet near the Sacramento River and the pumping of the sewage into the river.

STREETS.

NORTHAMPTON, MASS.—The highway committee has asked for an appropriation of $22,000, including the cost of a steam road roller.

SOMERVILLE, MASS.—The council has appropriated $45,000 for paving Somerville Ave.

SPRINGFIELD, MASS.—The committee has voted to ask for an appropriation of $10,000 for general improvements and $5,000 for macadamizing Front St.

BUFFALO, N. Y.—Bids are asked until March 1 for repairing asphalt pavements for one year. J. E. Ransom, Secy. Dept. Pub. Wks.

NEW YORK, N. Y.—Bids are asked by the department public works until March 6 for furnishing 20,000 cu. yds. sand and 6,000 l.n. ft. of bridgestone.

ROCHESTER, N. Y.—An ordinance is before the council for paving State St. with Medina blocks; estimated cost, $57,000.

JERSEY CITY, N. J.—The contracts for paving the Boulevard were awarded in eight sections as follows: Hudson County Contracting Co., $78,045, $64,460, $74,427, for sections 1, 2 and 3, respectively; Henry & McGilvney, $65,892, $63,255, $52,855, $50,415 and $50,523, for remaining sections.

ALLENTOWN, PA.—The citizens will vote on an issue of $100,000 bonds for paving.

COLUMBIA, PA.—The council has voted to issue $20,000 of 5-year 4% bonds for street improvements and to pay indebtedness.

WILMINGTON, DEL.—The city is reported as about to spend $15,000 for street and sewer work.

BRUNSWCK, MD.—Authority has been asked to issue $10,000 of bonds for street improvements.

LAUREL, MD.—W. H. Dorsey, Cy. Clk., writes us that the citizens will petition for authority to issue $90,000 of bonds to pave and macadamize the streets.

MURPHY, N. C.—The council is considering the holding an election to vote on an issue of $30,000 of bonds for street improvements.

JACKSONVILLE, FLA.—Bids are asked until March 1 for paving 69,055 sq. yds. with brick or asphalt blocks. The bids recently received for this work are published under Contract Prices, but were rejected.

ST. AUGUSTINE, FLA.—The question of paving the streets is being discussed by the citizens.

MONTGOMERY, ALA.—It is reported that $125,000 will be spent in paving the streets, work to be commenced early in the season.

MEMPHIS, TENN.—Bids are asked until March 8 for furnishing limestone curbstone, and granite and limestone blocks during 1894. J. J. Shea, Secy. Bd.

LOUISVILLE, KY.—Ordinances are before the council for improving streets aggregating about two miles in length.

CLEVELAND, O.—Bids are asked until Feb. 28 for the improvement of Gallup St. J. H. Farley, Dir. Pub. Wks.

DAYTON, O.—Bids are asked until March 21 for $500,000 of improvement bonds.

IRONTON, O.—The council is considering the paving and grading of several streets.

MOUNT VERNON, O.—Bonds for $13,000 have been sold for paving North Main St.

PAINESVILLE, O.—The council has proposed to pave about 3,000 lin. ft. of State St. with brick, the contract to be awarded about April 1.

PLEASANT RIDGE, O.—Bids are asked until March 13 for macadamizing Woodford Ave. Engr., J. M. Harper, Cincinnati.

WARREN, O.—Ordinances have been passed by the council for improving several streets. A. E. Andrews, Cy. Clk.

CROWN POINT, IND.—The council has ordered the laying of three miles of cedar block pavement, according to reports.

HUNTINGTON, IND.—Resolutions have been adopted for paving several streets with brick.

INDIANAPOLIS, IND.—Bids are asked by the board of public works until Feb. 26 for paving two streets with asphalt.——Other work is under consideration.

GRAND RAPIDS, MICH.—It is proposed to improve about 14 streets, at an estimated cost of about $82,000.

SAGINAW, MICH.—R. F. Johnson, Cy. Clk., informs us that the council has recommended the paving of 11 streets, estimated cost $166,000, but that it it not settled that more than three of these will be paved this season; estimated cost $86,922. The sewer work for the year will not be decided upon until April.

BLOOMINGTON, ILL.—It is reported that a contract will soon be awarded for paving a street one mile long, to cost about $35,000.

LA SALLE, ILL.—It is reported that $60,000 will be spent for sidewalks this year and that a large amount of paving will be done.

PEORIA, ILL.—Bids will be asked early in the spring for a large amount of brick paving, according to reports.

ROCK ISLAND, ILL.—Bids are asked until March 5 for paving two streets with brick. A. D. Huesing, Cy. Clk.

STREATOR, ILL.—It is stated that $60,000 will be spent for paving this year.

MARINETTE, WIS.—The council is again talking of paving Pierce Ave.; estimated cost, $26,355.

DUBUQUE, IA.—Bids are asked until March 3 for macadamizing Dock St. T. J. Cooney, Cy. Recorder.

HASTINGS, NEB.—Street paving bonds for $30,000 have been sold.

KANSAS CITY, MO.—Bids are asked by the board of public works until March 2 for paving with asphalt, brick and macadam, estimated to cost about $150,000.——The Kansas City Stock Yards Co. is reported to have awarded contracts for brick to pave 5½ acres of the company's yards. If this experiment proves successful it is probable that the entire yards will be paved with brick.

POMONA, CAL.—It is proposed to pave Second St with bituminous rock, to cost about $27,000.

SAN JOSE, CAL.—The council has adopted resolutions for improving 13 streets.

ELECTRIC LIGHT AND POWER.

BROOKLYN, N. Y.—Bids are asked until March 2 for electric lights and for gas lighting. A. T. White, Comr. Cy. Wks.

MONTCLAIR, N. J.—An informal application was made to the township committee on Feb. 19 for a franchise for incandescent street and commercial lighting by Paul Wilcox and other local capitalists. The matter was referred to the street lighting committee, M. N. Baker, Chn. A short time ago F. S. Woodward applied for a franchise for commercial lighting, which application was also referred to the above committee. Montclair is a

rapidly growing suburb of New York, with a population of about 11,000. Its streets are now lighted by 500 gas and 125 oil lamps, which only partially cover the town. Many of the citizens desire an electric lighting system.

WOODSTOWN, N. J.—It is reported that efforts are being made to secure an electric light plant to light the entire town.

YORK, PA.—Bids are asked until March 3 for electric street lighting for one or five years. T. B. Loucks, Secy. Com.

LYNCHBURG, VA.—The council has voted to put in a municipal plant, according to reports.

TERRA ALTA, W. VA.—A meeting was held Feb. 19 to consider the question of investing in an electric light plant.

SAVANNAH, GA.—Bids are asked until March 9 for 288 arc lights of 600 c. p. for 3 or 5 years; also for 20 lights, until Jan. 1, 1895. W. J. Winn, Cy. Engr.

HAMILTON, O.—The city has sold $50,000 of electric light bonds for $52,713.

WAVELAND, IND.—W. C. Carr, Crawfordsville, is interested in a proposed lighting plant at this place.

ASSUMPTION, ILL.—Press reports state that a company has been formed and will put in a plant at once, street lights to be of 50 c. p.

DENISON, IA.—The citizens are reported as agitating the question of electric lights.

MARION, IA.—The question of granting a franchise will be voted upon at an election March 5.

WASHINGTON, IA.—It is reported that this place will have electric lights.

HASTINGS, NEB.—A press report states that the Hastings Irrigation Canal & Power Co., noted in our issue of Feb. 1 as incorporated, has submitted a proposition to the city council asking for an election upon the question of issuing $75,000 of bonds to the company. The company agrees to build a canal from the Platte River to Hastings, erect power houses, etc., for the generation and distribution of 1,500 HP., and to furnish the city power for operating water-works, electric lighting and all other purposes at 50% of the present cost. Work on the canal is to be commenced within 30 days after the bonds are voted.

SPRINGFIELD, S. DAK.—A franchise for an electric light plant has been granted to F. A. Burdick, Aberdeen, the plant to be completed by June 1.

LEADVILLE, COLO.—The Citizens' Electric Light Co. has been organized by local capitalists and has petitioned for a 20-year franchise.

PORT ANGELES, WASH.—The Seattle "Post-Intelligencer" states as follows: W. C. Williams announces that he has arranged for the disposal of $37,000 of Port Angeles electric light bonds. He has the contract for constructing a power house and water power plant for the electric light works of this city, and has accepted the city's bonds in payment. The water which is to furnish the power will be conducted through a wooden pipe line from Little River to the power house, a distance of three miles, where it will be turned into a turbine wheel. It is estimated that by this means 500 HP. will be secured for the city's use.

WINDSOR MILLS, QUE.—The Canada Paper Co. has made a proposition to the council looking to the construction of a dam in the river and of a $40,000 electric power plant.

OTTAWA, ONT.—Bids are asked for the erection of a complete electric light plant for 500 arc lights of 2,000 c. p. Alderman Campeau, Chn. Lt. Com.

NEW COMPANIES.—Spanish & South American Love Electrical Traction Co., Jersey City, N. J.; $100,000; Henry Stanton, De Forest Manice, New York; A. I. Drayton, Jersey City.——Auerbach-Wolverton Electric Co., New York, N. Y.; $1,000,000; Geo. L. Record, Jersey City; S. H. Schwartz, J. S. Gallard, New York.——Merchants' Electric Light & Power Co., Gainesville, Tex.; $25,000; Edward J. O'Beirne, Dallas; Charles Zilker, W. H. McGaw.——Muskingum Electric Co., Zanesville, O.; $50,000.——R. Haas Electric Mfg. Co., Springfield, Ill.; $10,000; Rudolph Haas, Wm. L. Blucke.——Madison Light & Power Co., Chicago, Ill.; $10,000; Geo. M. Shinny, E. P. Ames, F. J. Baker.——Acme Lighting Co., Chicago, Ill.; $15,000; J. J. Arney, M. G. Armstrong, Thos. S. Jackson.——Colfax Electric Light & Power Co., Colfax, Ia.; $25,000.——Standard Light & Power Co. of Fort Worth, Tex., Fort Worth, Tex.; $60,000.

CONTRACT PRICES.

PIPE.—Cambridge, Mass.—L. M. Hastings, Cy. Engr., informs us that the following bids were received Feb. 15 for 24-in. water pipe: Builders' Iron Foundry, $23 per ton of 2,240 lbs. for 132 tons of 24-in. pipe, and $45 per ton for 12 tons of T branches; Warren Foundry & Machine Co., $22.90 and $47; R. D. Wood & Co., $22.50 and $51.50; Howard-Harrison Iron Co., $23.80 and $56; Reading Foundry Co., $25.21 and $56.

DRAINAGE DITCH.—Prophetstown, Ill.—F. W. Sears, Engr., writes us that contracts have been awarded for about 30½ miles, 250,000 cu. yds., of drainage ditch in Union drainage district, of this and other townships, as follows: J. H. and O. T. Hanson, Princeton, 76,000 cu. yds., at 6 to 8.9 cts. per cu. yd.; Park Little, Prophetstown, 16,000 cu. yds., at 8 and 9 cts.; Pollard & Co., Champaign, 113,000 cu. yds., at 8 cts.; Mike Callaghan, Sterling, 14,000 cu. yds., at 7½ cts.; John Drew, Sterling, 3,500 cu. yds., at 6.9 cts.

CRUSHED STONE.—Easton, Pa.—H. R. Fehr, Cy. Engr., informs us that the following bids have been received for furnishing the city with crushed stone: Smalley Bros., Plainfield, N. J., $1.80 per ton for trap rock, 1½ to 2 ins., and $1.90 for ¾ to 1-in., delivered f. o. b. cars in this city; A. M. Stephens, Allentown, Pa., $1.05 for granite, f. o. b. cars here; Wm. Haelig, Bound Brook, N. J., $1.55 for trap rock, f. o. b. cars here (awarded contract); T. M. Lesher & Son, Easton, $1 for limestone, delivered on street (awarded contract); J. E. Miles, Easton, $1.18 for limestone and $2.05 for trap rock, delivered on streets. This last b'd was submitted last month and was the only one received at that time, as stated Jan. 25.

SEWERS.—Atlanta, Ga.—The contract for constructing all brick and pipe sewers authorized for one year has been awarded to W. D. Palmer, Atlanta, at the following prices: Brick, $10 per M laid; rubble masonry, $1.50 per cu. yd.; curbstone, $2.50 per cu. ft.; cut flagging, $1.25 per sq. ft.; lumber, $9.50 per M ft.; excavation 10 ft. deep, 20 cts. per cu. yd.; 15, 20 and 25 ft. deep, 25 cts.; concrete, etc., $2 per cu. yd.; rock excavation, $1.25 per cu. yd.; laying 8, 10 and 12-in. pipe, 8 cts. per lin. ft.; 15 and 18-in., 10 cts.; 20, 22 and 24-in., 14 cts.

Evansville, Ind.—The contract for 15-in. pipe sewer in Fifth St. has been awarded to Frank McGuire, at $1.05 per lin. ft., $25 for each manhole, $35 for each inlet, $2 for each Y, the other bids being G. M. Uhl, $1.25; J. M. Megular, $1.40; J. L. Bray, $1.25, and Michael Weber, $1.30 per lin. ft. for the sewer. A contract for a 10-in. pipe sewer was awarded to Michael Weber, at 57 cts. per lin. ft, $25 for each manhole, $36 for each inlet and $1.50 for each Y.

WATER-WORKS EXTENSIONS.—Tonawanda, N. Y.—Voorhees & Witmer, Engrs., Buffalo, inform us that the following bids were received for the water-works extensions, noted last week as awarded to Dwyer & Huntington, at $36,504; the builders being, 1, R. F. Norton, Attica; 2, Fales & O'Donnel, Tonawanda; 3, Ayrault Bros., Tonawanda; 4, H. Newcome, Niagara Falls; 5, Dwyer & Huntington, Buffalo; 6, E. H. Rodgers, Tonawanda, the contractor to furnish all material:

Cast iron pipe.		1.	2.	3.	4.	5.	6.
12 in., 5,000 lin. ft. at		$1.45	$1.15	.....	$1.15	$1.12	$1.50
8-in., 7,000	" "	.88½	.76	.....	.76	.66	.90
6-in., 3,500	" "	.63	.56	.....	.56	.50	.64
4-in., 1,000	" "	.49	.41	.....	.41	.38	.50
Hydrants, 135, each		31.87	24.70	$22.00	24.63	.....	32.00
4-in. g'te v'l's, 15	"	10.20	7.91	.....	7.91	7.50	12.00
6-in. "	38 "	16.50	13.44	.....	13.44	12.00	17.00
8-in. "	4 "	24.22	18.13	.....	18.13	18.00	25.00
12-in. "	5 "	42.18	33.00	25.55	33.00	33.50	45.00
Valve boxes, 62,	"	.....	3.30	3.35	3.50	4.00	.....
Specials, per lb		.04	.02½	....	.02½	.02½	.04
Crossing canal		$1,500	$1,200	$1,190	$1,200	$300	.....
Wooden pipe:							
12-in., per lin. ft.		1.65	1.53	1.30	.....	.....	1.70
8-in., " "		1.03	.99	.80	.....	.....	1.05
6-in., " "		.76½	.64	.58	.....	.....	.77
4-in., " "		.51	.43	.38	.....	.....	.52
Specials with w. p.		.05½	...	.04	.....	.....	.05

LEVEE WORK.—New Orleans, La.—The Pontchartrain district commissioners have awarded contracts for about 100,000 cu. yds. of work to the Eltringham Const. Co., at 27½ cts. per cu. yd.

CYPRESS BLOCK, GRANITE, ETC., PAVING.—Jacksonville, Fla.—The following bids have been received for street paving, the board of public works to do the grading unless the price is noted as complete: J. B. Brown, macadam, 70 cts. per sq. yd.; T. A. Hugrim, granite, $2.90; Wilson & Thatcher, granite, $2.42, complete; $2.33; brick, grout filling, complete, $2.13; $2.04; sand filling, complete, $2.03; $1.94; asphalt blocks, complete, $2.90; sheet asphalt, complete, $3.10. T. H. Bowman, sheet asphalt, complete, $3.75. T. Newnham, cypress blocks, complete, 83.7 cts.; 71.3 cts. (awarded contract). M. E. Maher, granite, complete, $2.52; $2.32; brick, grout filling, complete, $1.93; $1.73 Venable Bros., granite, complete, $1.89 (awarded contract); $1.78; brick, grout filling, complete, $1.83; $1.73; sand filling, compete, $1.75; $1.65. Lithomia Granite Co., granite, complete, $2.59; $2.33. Jenkins & Brantley, granite, complete, $2.47; $2.34. Jacksonville Paving Co., granite, complete, $2.44; $2.34; cypress blocks, 95 cts.; complete; 87½ cts. Davis & Archer, granite, complete, $2.37; $2.31; brick, grout filling, complete, $2.11; $2.05; sand filling, complete, $2.01. A. M. Smith, granite, complete, $2.17; $2.00. Tennessee Paving Co., Columbia granite, complete, $2.40; $2.41, and $2.56 and $2.41 for Winsboro granite. Southern Const. Co., brick, grout filling, complete, $1.77; $1.64; sand filling, complete, $1.68; $1.56. Washington Asphalt Co., asphalt blocks, complete, $2.25; $2.05. All bids for brick paving were rejected and work will be readvertised.

TRENCHING AND PIPELAYING.—Syracuse, N. Y.—W. R. Hill, Ch. Engr., informs us that the following bids were received Feb. 16 for trenching and pipelaying, the total bids being: 1, P. H. Harrison & Son, Newark, N. J., $6,715; 2, Cook & Read, Cleveland, $4,608; 3, Jas. Kinney and W. J. Dwyer, Syracuse, $7,147; 4, John Kelley, Syracuse, $4,897; 5, Richard Dawson and W. T. O'Connor, Syracuse, $4,343.

Quantities.		1. $.	2. $.	3. $.	4. $.	5. $.
Bailing and draining....		500.00	400.00	500.00	300 00	100.00
Hauling pipe, o'c.....	160 tons.	1.00	.75	.79	.75	.85
Earth excav.	3,000 cu. yds.	1.00	.75	1.07	.75	.63
Puddle.....	600 "	1.00	.35	1 25	.40	.63
1 in. lead pipe, laid.....	200 lin. ft.	.30	.15	.21	.20	.18
Laying 4-in p.	50 "	.10	.08	.31	.10	.11
" 6-in..	200 "	.15	.10	.33	.15	.15
" 8-in..	120 "	.16	.12	.35	.25	.27
" 10-in..	30 "	.21	.18	.37	.25	.23
" 12-in..	50 "	.30	.22	.41	.30	.28
" 16-in..	1,800 "	50	.31	.70	.40	.35
" 20-in..	230 "	1.00	.45	.80	.56	.65
" 24 in..	150 "	1.00	.65	.90	.60	1.25
Remov., etc., 12-in. iron p.	200 "	.15	.12	.11	.15	.08
Remov., etc., cement pipe	1,000 "	.15	.05	.07	.05	.06
Loose stone, in place.....	10 cu. yds.	2.00	2.00	1.75	2.00	1.75
Rubble mas. in cement...	150 "	5.00	4.00	4.00	5.00	3.85
Brick mas. in cement.....	10 "	9.00	9.00	7.50	8 50	8.50

MISCELLANEOUS CONTRACTS AND SUPPLIES.

CITY HALL.—Union City, Tenn.—The council is considering the question of a new city hall and other improvements.

DITCH WORK.—Penfield, N. Y.—Bids are asked until April 2 for certain ditch or channel repairs. Geo. W. Clark, Water Comr.

GAS FRANCHISE.—Fulton, Ill.—The council has granted a franchise to R. R. Bemiss and others for a gas plant and for a system of pneumatic tubes.

SEA WALL BONDS.—Galveston, Tex.—The council has voted unanimously in favor of issuing $200,000 of bonds for constructing a sea wall and breakwater.

CITY HALL DOME.—San Francisco, Cal.—All the bids for the construction of the new city hall dome have been rejected. The lowest was $221,950, as stated last week.

CANAL IMPROVEMENTS.—Albany, N. Y.—The governor has signed the bill appropriating $35,000 for strengthening the embankment of the canal near Schenectady.

DRAINAGE CANAL.—Chicago, Ill.—The drainage board has declared the contract for section I. of the drainage canal to be forfeited and has voted to receive new bids until April 18 for the work.

DAM.—Richmond, Que.—Samuel Cleveland and F. H. Nunns are interested in the Richmond Water Power & Mfg. Co., organized to construct a dam in the St. Francis River and to develop power for manufacturing purposes; capital stock, $40,000.

STREET SPRINKLING.—Nashville, Tenn.—F. E. Kuhn, Secy. Bd. Pub. Wks., writes us that the contract for sprinkling about 57 miles of streets, from two to four times a day, has been awarded to H. C. Pollman & Bro., St. Louis, at $14,877.

WATER POWER CANAL.—Omaha, Neb.—The engineers have reported to the commercial club that the proposed Platte River Canal and water power system can be constructed for about $300,000, and efforts are being made to raise the necessary capital to undertake the work.

TIMBER, ETC.—New York, N. Y.—The department of docks will receive bids until March 8 for 749,034 ft. B. M. of spruce timber; for steam fittings, wrought iron and steel, tools and pier iron; also for building and furnishing a movable steam derrick, with all appurtenances.

DRAINAGE.—St. Charles, Mo.—It is reported that an association is being formed for constructing a ditch 1¾ miles long to drain 3,000 acres of land between Baschertown, Stonebraker's lane on the east and the Mississippi River below the mouth of Dardenne on the west, the Chicago, Burlington & Quincy R. R. on the north, and Elm Point on the south.

IRON WORK.—Washington, D. C.—R. H. Hood, Engr., informs us that the lowest bids received Feb. 15 for the ironwork for the post-office building at Omaha, Neb., were the Paxton Vierling Iron Wks., Omaha, at $28,650 for the first and second floors and $11,891 for the upper floor, and the Milwaukee Bridge & Iron Wks., at $27,449 and $12,951, the other bidders being the Union Foundry Wks., St. Paul Foundry Co., Koken Iron Wks., Brown-Ketcham Iron Wks., L. Schreiber & Sons Co., F. J. Myers Mfg. Co., Dearborn Foundry Co., Wm. Bayley & Sons Co., Binder & Seifert, Cincinnati Architectural Iron Wks., Benj. Hyde, Chicago, South Halstead St. Iron Wks., Wisconsin Bridge & Iron Co., Phoenix Foundry & Machine Co.

DREDGING.—Buffalo, N. Y.—The department of public works will receive bids until March 1 for dredging Buffalo River, Blackwell Canal, Buffalo Harbor and Peck Slip, four contracts.——Bids will be received at the U. S. Engineer Office until March 1 for dredging in Dunkirk Harbor. Maj. E. H. Ruffner, U. S. A.

Wilmington, N. C.—Bids will be received at the U. S. Engineer Office until March 10 for dredging at Shad Island Bend, Roanoke River, N. C.; also in the Inland Waterway between Beaufort Harbor and New River, N. C. Maj. W. S. Stanton, U. S. A.

Oakland, Cal.—The council is considering an appropriation of $12,500 for dredging Lake Merritt.

Philadelphia, Pa.—Bids are asked until March 5 for dredging docks. Geo. F. Sproule, Secy. Bd.

INDUSTRIAL NOTES.

THE GRANITE RAILWAY CO., Concord, N. H., has the contract for 225,000 ft. of granite for the U. S. building at Rochester, N. Y.

THE POND MACHINE TOOL CO., of Plainfield, N. J., has an order for machine tools for the 16-in. gun plant at the Watervliet arsenal.

THE UNITED BUILDING MATERIAL CO. has removed its office from 54 Pine St. to the Cable Building, 621 Broadway, New York city.

THE ANNISTON PIPE WORKS, of Anniston, Ala., are reported as having enough orders on hand to keep them running for about three months.

THE BETHLEHEM IRON CO., of South Bethlehem, Pa., has voted to increase its capital stock from $5,000,000 to $10,000,000. The steel rail mill is to be reconstructed.

THE WISCONSIN BRIDGE & IRON CO., of Milwaukee, Wis., has a contract for two bridges on the Wisconsin Central Ry.; one at Zill's Landing and the other at Chippewa Falls.

THE CLAYTON AIR COMPRESSOR WORKS have removed their offices and salesrooms to the second floor of the Havemeyer Building, 26 Cortlandt St., New York, retaining their former store as a warehouse.

THE SECKNER CO., Unity Building, Chicago, has recently completed the erection of a 406 ft. bridge at Frankfort, Ky., and has been awarded a $45,000 contract for public improvements at Frankfort. Its bid of $27,000 for a water-works and electric light plant for Reedsburg, Wis., was the lowest received.

NEW COMPANIES.—Alexander Car Replacer Mfg. Co., Scranton, Pa.; $100,000; Pres., J. A. Jermyn; Secy., James Russ.——New Jersey General Security Co., Paterson, N. J.; $2,000,000, commencing with $500,000; to build water and gas works, etc.; G. A. Hobart, Paterson; H. C. Fahnestock and J. A. Garland, New York, N. Y.——Knapp Railway Car Ventilator Co., St. Louis, Mo.; $100,000; Charles Knapp, C. S. Crane and G. W. Ford.——St. Louis Well & Drilling Co., St. Louis, Mo.; $30,000; G. P. Wolf, T. P. Sullivan and W. H. Caffrey.——American Railway Supply Co., Chicago, Ill.; $100,000; lumber and contracting; George W. Haines, J. J. Armstrong and C. F. Haines.——Milwaukee Sand & Gravel Co., Milwaukee, Wis.; $50,000; J. T. Bannen, T. R. Bentley and C. B. Roberts.——Duplex Improved Air-Brake Co., East St. Louis, Ill.; $2,500,000; to operate the patents of J. A. Hoff and William Pickles; Raymond Cleary, E. C. Donk and John Mullally, all of St. Louis, Mo.——Automatic Vertical Car Coupler Co., Gano, Ill.; $10,000; Otto A. Klein, M. W. Matson and Martin Yost.

METAL MARKET PRICES.

RAILS.—New York: $24 at eastern mills and $25 at tidewater; girder rails, $28; old rails, $11.75 to $12 for iron and $9 to $9.50 for steel. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $11.50 to $12 for iron and $6.75 to $10 for steel.

TRACK MATERIAL.—New York: angle bars, 1.3 to 1.4 cts.; spikes, 1.7 to 1.9 cts.; track bolts, 2.2 to 2.4

cts. with square and 2.3 to 2.5 cts. with hexagon nuts. Chicago: angle bars, 1.4 cts.; spikes, 1.8 to 1.85 cts.; track bolts, 2.45 to 2.5 cts. with hexagon nuts.

FOUNDRY PIG IRON.—New York: $12 to $14. Pittsburg: $10.75 to $12. Chicago: $11.75 to $13.

LEAD.—New York: 3.2 to 3.3 cts. Chicago: 3.1 cts.

NAILS.—Pittsburg: $1.10 to $1.15 for wire and $1 to $1.05 cts. for cut at mill.

STRUCTURAL MATERIAL.—New York: beams, 1.45 to 2.2 cts.; channels, 1.45 to 1.6 cts.; angles, 1.35 to 1.5 cts.; tees, 1.65 to 1.9 cts.; universal mill plates, 1.35 to 1.5 cts.; steel plates, 1.3 to 1.5 cts. for tank, 1.5 to 1.65 cts. for shell, 1.7 to 2 cts. for flange, 2 to 2.5 cts. for firebox. Pittsburg: beams, 1.25 to 1.35 cts.; channels, 1.25 to 1.35 cts.; angles, 1.25 to 1.3 cts.; tees, 1.4 to 1.5 cts.; universal mill plates, 1.25 to 1.3 cts.; steel plates, 1.25 to 1.3 cts. for tank, 1.4 to 1.5 cts. for shell, 1.5 to 1.6 cts. for flange, 1.75 cts. for ordinary firebox and 2 cts. for railway firebox. Chicago: beams, 1.45 to 1.5 cts.; channels, 1.45 to 1.5 cts.; angles, 1.35 to 1.45 cts.; tees, 1.75 to 1.8 cts.; universal plates, 1.4 to 1.5 cts.; steel plates, 1.4 to 1.5 cts. for tank, 1.7 to 1.8 cts. for shell, 1.8 to 1.9 cts. for flange, 2 to 5 cts. for firebox.

WATER-WORKS CONSTRUCTION.

ADVERTISEMENT FOR PROPOSALS.

Office of the City Clerk, City of Buffalo, Wyoming, February 1, 1894.—The city of Buffalo, Wyoming, invites proposals for the construction of its proposed Gravity System of Water-Works in accordance with the plans and specifications on file in the office of the undersigned. Sealed proposals will be received by the undersigned up to 12 o'clock noon on March 31, 1894, and the bids will be opened by the Board of Trustees at 1 o'clock p. m. on that day. The right is reserved to reject any and all bids. For instructions as to manner and form of submitting bids, terms and conditions of payment, and all other necessary information call on or address

WM. H. FENN,
8-2t City Clerk, Buffalo, Wyoming.

PARK AVENUE IMPROVEMENT.

NOTICE TO CONTRACTORS.

Proposals will be received up to 3 o'clock p. m., Thursday, March 8th, 1894, by the Commissioners for the Park Avenue Improvement above 106th street for the furnishing of all materials and erecting complete, Timber, Trestlework and temporary Bridge Trusses on Park Avenue between 106th and 130th Streets, New York, requiring about 2 million feet, board measure, of Southern Yellow Pine framing Timber and about 400 Tons of Ironwork. The plans can now be seen, and copies of the specifications and forms of agreement and proposal blanks obtained, on application at the office of the Board, No. 132 Park Ave., Room No. 4.

New York, February 22d, 1894. 8-2t

NOTICE TO CONTRACTORS.

SEWER MATERIALS.

Sealed proposals for furnishing brick cement and vitrified sewer pipe will be received by the Sewer Committee of the city of Newton, Commonwealth of Massachusetts, at the office of the City Engineer, City Hall, West Newton, Mass., until 12 o'clock noon of March 8, 1894. The award of the contract, if awarded, will be made as soon thereafter as practicable.

All proposals must be made upon a blank form furnished by the city, and must be accompanied by a certified check for two hundred dollars ($200) drawn upon some National Bank of Newton or Boston, and made payable to the City Treasurer.

The approximate amount of materials required is as follows:

2¼ million hard-burned brick.
9,000 barrels American cement.
1,000 barrels Portland cement.
34,000 linear feet of 4-inch vitrified sewer pipe.
4,000 linear feet of 5-inch vitrified sewer pipe.
5,000 linear feet of 6-inch vitrified sewer pipe.
45,000 linear feet of 8-inch vitrified sewer pipe.
9,000 linear feet of 10-inch vitrified sewer pipe.
3,000 linear feet of 12-inch vitrified sewer pipe.
8,000 linear feet of 15-inch vitrified sewer pipe.
3,000 linear feet of 18-inch vitrified sewer pipe.
350 linear feet of 20-inch vitrified sewer pipe.
250 linear feet of 24-inch vitrified sewer pipe.

The committee reserve the right to reject any or all proposals if they deem it for the interest of the city to do so.

Specifications and forms of contract may be obtained at the office of the City Engineer.

HENRY H. HUNT,
Chairman Joint Standing Committee on Sewers.
H. D. WOODS, City Engineer.
8-2t

PROPOSALS FOR EXCAVATING.

SIXTH LETTING.

Sanitary District of Chicago.

TO CONTRACTORS.

Sealed proposals addressed to the Board of Trustees of the Sanitary District of Chicago and indorsed "Proposals for Excavating a Portion of the Main Drainage Channel" will be received by the Clerk of the said Sanitary District at Room H, Rialto Building, Chicago, Ill., until 12 m. (standard time) of Wednesday, the 18th day of April, 1894, and will be publicly opened by the said Board of Trustees at the regular meeting held that day, or at a special meeting called for that purpose.

The work for which the said tenders are invited is the excavation of that portion of the main drainage channel for the said Sanitary District, known as contract section One (1), extending from station 733 to station 800, and consists in all of about 459,724 cubic yards of rock, of about 1,662,476 cubic yards of earth, the building of 60,188 cubic yards of rubble wall, and 1,154 square yards of slope paving; and further, for the excavation of that portion of the said main drainage channel, known as contract sections N and O, extending from station 154 + 23 to station 38 + 80, consisting in all of 2,552,732 cubic yards of earth excavation.

Each of said sections will be treated as a separate contract in canvassing proposals and making awards. As all awards will be made by individual sections, each bidder must make prices for each section separate and distinct from every other.

Each proposal for each section to be accompanied by a certified check or cash to the amount of $5,000.

All certified checks to be drawn on some responsible bank doing business in the city of Chicago and be made payable to the order of the Clerk of the Sanitary District of Chicago. Said amount of $5,000 to accompany each bid for each of the respective sections will be held by the Sanitary District until all of said proposals have been canvassed and contracts awarded and signed, the return of said check or cash to the bidder to whom said work shall have been awarded being conditioned upon his appearing within ten days after notice of such award being given, with bondsmen and executing a contract with the Sanitary District for said work so awarded, and giving a bond satisfactory to the Board of Trustees for the fulfillment of the same in the amount of $100,000 for section 1, and $75,000 each for sections N and O.

All proposals must be made upon the blank forms furnished by the Sanitary District and must give the price for each separate item of work.

The bids will be compared on the basis of the Engineer's approximate estimate of quantities, which will be furnished with copies of the specifications.

No proposal will be considered unless the party making it shall furnish evidence satisfactory to the Board of Trustees of his ability to do the work, and that he has the necessary pecuniary resources to fulfill the conditions of the contract, provided such contract shall be awarded him.

Bidders are required to state in their proposals their individual names and places of residence in full.

Specifications and plans may be seen at the office of the Chief Engineer, Rialto Building, Chicago, Ill.

The said Board of Trustees reserves the right to reject any and all bids.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of Its Board of Trustees.
Attest: THOMAS F. JUDGE, Clerk.
Chicago, Ill., Feb. 16, 1894. 8-1t

SEALED PROPOSALS FOR ARTESIAN WELLS.

Sealed proposals will be received by the City Clerk, at his office in Boone, Iowa, until 7 p. m., March 14, 1894, for sinking, testing and tubing an artesian well to a depth of not less than (500) five hundred feet, in the city of Boone, well to be large enough to receive twelve-inch tubing to the depth of (500) five hundred feet if necessary, and to be continued as much deeper as desired by the city, with a hole large enough to receive six inch tubing, inside measure, the city to furnish steam and tubing, all other tools, pumps, machinery, labor and materials to be furnished by bidder. Bidder to furnish certified check of ($100) one hundred dollars with bid, and ($1,000) one thousand dollar bond with contract. Bidder to test well with not less than a ten-inch pump when required by the city, with compensation named in bid for each test. Payment on completion of well. The right to reject any or all bids is reserved. JESSE L. HULL,
8-1t City Clerk.

PROPOSALS FOR WATER-WORKS CONSTRUCTION.

City Clerk's Office,
Chanute, Kan., Feb. 16, 1894.

Sealed proposals will be received by the City Clerk of the City of Chanute, Kan., until 8 o'clock p. m. March 20, 1894, for the construction of a system of water-works, in accordance with the plans and specifications prepared by John M. Walker, Engineer, and now on file with the City Clerk. Proposals for the whole work will be received, and a certified check of $1,000 must accompany each bid.

The Council reserve the right to reject any or all bids.

The contract will be let upon the condition that the contractor take city bonds in full satisfaction, at par value, unless said bonds are sold prior to that time.

FRANK HARDESTY, Mayor.
Attest: J. W. BUCHANAN, City Clerk.
J. M. WALKER Consulting Engineer.
8-1t

NOTICE TO CONTRACTORS FOR STREET PAVING.

Sealed proposals will be received until 7:30 p. m., Thursday, March 1, 1894, by the undersigned for the City of Easton, Pa., at the office of the City Engineer, Municipal Building, for the paving of Northampton Street, between the Delaware Bridge and Centre Square, with vitrified paving brick on a six-inch concrete base, in accordance with the plans and specifications on file in the office of the City Engineer.

The amount of paving required is about 5,470 square yards.

Each proposal must be made upon the "form" furnished by the City Engineer.

No bid will be considered unless accompanied by a certified check, drawn to the order of the Treasurer, draft on New York or money to the amount of $300. All such deposits, except that of the successful bidder, will be returned to the person making the same within ten days after the contract is awarded. If the successful bidder shall refuse or neglect, within ten days after notice that the contract has been awarded to him, to execute the same and furnish a bond acceptable to a joint convention of Councils in the sum of $5,000, the amount of deposit made by him shall be forfeited to and retained by the City of Easton as liquidated damages for such neglect or refusal; but if he shall execute the contract within the time aforesaid, the amount of his deposit will be returned to him.

Samples of brick, sand and gravel, properly labeled, must be submitted on or before Feb. 28, 1894.

The city reserves the right to reject any or all bids.

Specifications, blank forms and all available information will be furnished on application to this office.

H. R. FEHR, City Engineer.
Municipal Building.
Easton, Pa., Feb. 3, 1894. 6-3t